THE BYZANTINE VERSION OF THE *TOLEDAN TABLES*: THE WORK OF GEORGE LAPITHES?

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VATICANUS graecus 212[1] consists of two codices bound together. The second of these (folios 105–156) is a fragmentary but extremely valuable copy of the Greek version of the astrological works of Theophilus of Edessa; it was copied toward the end of the fourteenth century. The first contains several short texts on the astrolabe followed by the unique copy of a Byzantine translation of the *Toledan Tables* (folios 26–104^{v}); it was copied in the middle of the fourteenth century, apparently by the translator himself. The manuscript was purchased in Crete by Laudivius Zacchia[2] according to a note on fol. 1:[3] *Laudivii Equitis hierosolymitani liber in Creta emptus.* It is presumed by Devreesse that Laudivius' collection of manuscripts entered the Vatican Library during the pontificate of Paul III (1464–71),[4] but Vat. gr. 212 does not appear in the inventory of 1475; it makes its first appearance in that of 1481, where it is described as: *De organis Astrolabium, ex papyro in tabulis.*[5] Laudivius may have bought it while he was in the Levant in the summer of 1475.[6]

The *Toledan Tables* were composed originally in Arabic in about 1070 by al-Zarqālī[7] on the basis, primarily, of the *Zīj al-Sindhind* written by al-Khwārizmī[8] in the early ninth century, following the mixtures of Indian, Sasanian, and Greek material found in the works of the late eighth-century astronomers al-Fazārī[9] and Ya'qūb ibn Ṭāriq,[10] and of the *Zīj al-Ṣābi'* of al-Battānī (died 929).[11] Though the Arabic version is lost, there exist more than one hundred

[1] Described by F. Cumont and F. Boll, in *Catalogus Codicum Astrologorum Graecorum*, V, pt. 1 (Brussels, 1904), 64–71; and by I. Mercati and P. F. de' Cavalieri, *Codices Vaticani Graeci*, I (Rome, 1923), 269–74.

[2] On Laudivius, see F. Babinger, *Laudivius Zacchia, Erdichter der "Epistolae Magni Turci,"* SBMun, Phil.-hist.Kl., 13 (Munich, 1960).

[3] A facsimile is given by Babinger, *ibid.*, 42.

[4] R. Devreesse, *Le fonds grec de la Bibliothèque Vaticane des origines à Paul V*, ST, 244 (Vatican City, 1965), 42.

[5] *Ibid.*, p. 93, no. 243. For its appearances in later catalogues, see p. 130, no. 246 (1484); p. 165, no. 167 (*ca.* 1510); p. 199, no. 279, and p. 214, no. 584 (1518); p. 294, no. 523 (1533); p. 349, no. 531 (1539?); and p. 437, no. 4, 74 (*ca.* 1550).

[6] Babinger, *op. cit.*, 32.

[7] See J. M. Millás Vallicrosa, *Estudios sobre Azarquiel* (Madrid-Granada, 1943–50), 22–71.

[8] This survives in the Latin translation made by Adelard of Bath in 1126 of the revision due to al-Majrīṭī (died *ca.* 1008); this was edited by A. Bjørnbo, R. Besthorn, and H. Suter, *Die astronomischen Tafeln des Muḥammed ibn Mūsā al-Khwārizmī*, (Copenhagen, 1914), and translated into English with a commentary by O. Neugebauer, *The Astronomical Tables of al-Khwārizmī* (Copenhagen, 1962). On al-Khwārizmī himself, see G. Toomer, in *Dictionary of Scientific Biography*, 7 (New York, 1973), 358–65. On the Indian influence on al-Khwārizmī, see D. Pingree, "The Indian and Pseudo-Indian Passages in Greek and Latin Astronomical and Astrological Texts," *Viator*, 7 (1976), 141–95, esp. 151–69.

[9] *Idem*, "The Fragments of the Works of al-Fazārī," *JNES*, 29 (1970), 103–23, and in *Dictionary of Scientific Biography*, 4 (1971), 555–56; for the eclectic character of early Islamic astronomy, see *idem*, "The Greek Influence on Early Islamic Mathematical Astronomy," *JAOS*, 93 (1973), 32–43.

[10] *Idem*, "Fragments of the Works of Ya'qūb ibn Ṭāriq," *JNES*, 27 (1968), 97–125; and E. S. Kennedy, "The Lunar Visibility Theory of Ya'qūb ibn Ṭāriq," *ibid.*, 126–32.

[11] Edited by C. A. Nallino with a Latin translation, *Al-Battānī sive Albatenii Opus astronomicum*, Pubblicazioni del Reale Osservatorio di Brera in Milano, 40 (Milan, 1899–1907). On al-Battānī, see W. Hartner, in *Dictionary of Scientific Biography*, 1 (1970), 507–16.

manuscripts of a Latin translation,[12] apparently due to the industry of Gerhard of Cremona (died 1187).[13] This enormous number of copies attests to the popularity of the work, and helps to explain why it was selected for a Greek translation.

The Greek translation was made in the 1330's or early 1340's; the introductory section (folios 26–41^{v}) which is not part of the *Toledan Tables*, but which demonstrates a thorough knowledge of them, mentions the dates 19 April 1334 (folio 35^{v}), 1 January 1335 (folio 37^{v}), 3 March 1337 (folio 38), 7 July 1339 (folio 38), 23/24 and 27/28 April 1340 (folio 38^{v}), and 11 April 1341 (folios 26^{v}–27). Moreover, it seems to have been written on Cyprus, as the rule on folio 27 includes a time correction for the longitudinal difference between Alexandria and that island. This argument is strengthened by the peculiar spellings of the Latin words transcribed in the tables, wherein *c* is replaced by *ss* or *s*: see *ressessionis* (folio 79^{v}); πορσίονες (for *porciones*) and *sirculus* (folio 80); *lanseator* (folio 84^{v}); *sivita* and *sivitas* (folio 85); φάσεις (for *facies*) (folios 85^{v}–87 and 100); and *asensiones* and *revolusiones* (folio 88). Such spellings also occur in Latin documents from Cyprus; for instance, one finds such phrases as: *Raimondus Dey grassia arssiepiscopus Nicossienssis*.[14] The French influence is also apparent in the geographical list on folio 85, where "Siege dou roy de Frans" replaces the Latin *Sedes regis Francorum*. The Latin language itself, however, is called by the translator Ἰταλικός (folio 80; cf. folio 82^{v}, and Lapithes' letter to Gregoras cited below).

The King of Cyprus at the time of the translation was Hugh IV, who ruled from 1324 till 1359.[15] He was one member of the Lusignan dynasty who fostered Greek and Latin learning, as we are informed by Nicephorus Gregoras in his description of his visit to George Lapithes on Cyprus:[16]

> The king himself shared without moderation the philosophy of the Latins, and therefore always kept about him many learned Latins. But he preferred the learning and company of George [i.e., Lapithes]; for, he said, the learned become tyrants in a gathering of the learned. Therefore he was persuaded that in keeping him he also kept with him both learnings —that of the Greeks, I mean, and that of the Latins. For George was clever in these matters according to each learning and according to each language.

A little further on in his narrative Nicephorus indicates George's (and Hugh's) interest in astronomy and astrology:[17]

> He brought me also such works of astronomy as you yourself had sent him at different times, and he was enthusiastic to embrace for him in a few syllables most of the labors [of

[12] There are 128 items in the list compiled by G. J. Toomer, "A Survey of the Toledan Tables," *Osiris*, 15 (1968), 5–174, esp. 160–70.

[13] This is suggested by the table of rising-times for the latitude of Cremona, which is table 19 Toomer, found on folios 93–93^{v} of Vat. gr. 212. There are several twelfth-century manuscripts included in Toomer's list.

[14] J. Richard, *Documents chypriotes des Archives du Vatican (XIV^{e} et XV^{e} siècles)* (Paris, 1962), 14.

[15] See G. Hill, *A History of Cyprus*, II (Cambridge, 1948), 285–307.

[16] *Historiae Byzantinae*, XXV, 9, Bonn ed. (1855), III, 29.

[17] *Ibid.*, XXV, 11, vol. III, pp. 32–33. Virtually the only other Cypriote in Byzantine times whom I know to have paid some attention to astronomical phenomena is Neophytus, who observed solar eclipses on Sunday 11 April 1176 and on 14 (really 13) September 1178; see I. P. Tsiknopoulos, Κυπριακὰ τοῦ ἁγίου Νεοφύτου, in Κυπρ.Σπουδ., 24 (1960), 111–49, esp. 138–39.

astronomy], and in particular those of such hypotheses as are difficult. He was no less zealous for Ptolemy's Ἀποτελεσματικὴ Τετράβιβλος, but with greater industry searched for it and all the books that still existed composed about such matters both by Ptolemy's predecessors and by more recent authors, as well as those that had been written in antiquity by the Chaldaeans and the Persians. Whatever goes beyond the limits of the sacred laws and stretches its foot into alien territory he shook off and spat upon as being useless to those who desire to be pious, but whatever pertains correctly to the causes of things he glady accepted in their entirety. He did this in order not to be confuted by the clever words concerning such matters of the Latins there, with the king himself, who busied themselves with this branch of science, since the Egyptian Arabs who were nearby often made the journey across the sea to the king for scientific discourse as well as for ambition, which involves the great ostentation of those Arabs whose whole life it would occupy if some vestige were left, still preserved, of the ancient Chaldaean science. For they say that, since it was determined by the Creator that all things subject to generation and decay suffer and are endowed with form because of the nature and motion of the heavenly bodies, and since the flow of material nature is, as it were, regulated and ordered by their aspects and their relationships with terrestial things, it is necessary not to consider it all-important to know one [i.e., astronomy], but not the other [i.e., astrology].

One result of Hugh's contacts with the Egyptian Arabs was probably the presentation of a silver-plated copper basin with a Cufic inscription and astrological decorations; he is known also to have purchased a clock from Mondino of Cremona in 1334.[18] It is most probably to Hugh that the words διὰ τὸν ῥήγαν[19] written on folio 33^{v} of Vat. gr. 212 refer. This circumstance, and the first sentence of the passage from Gregoras quoted above, suggest that Lapithes might be the translator of the *Toledan Tables*; this supposition is supported by one of his letters, writen to Gregoras before his visit to Cyprus, requesting astronomical information in order to compare it with the methods of Ptolemy and of the Latins, who use Islamic sources:[20]

Please answer these brief questions for me, who desires your fulfilling [this request], as, they say, matter does form. With what sort of astronomical tables do you make your calculations? What epoch-positions do you accept, and for what time of day are they given? How long is the interval from the epoch till the present? For I don't believe that you use the Ptolemaic tables, since they have become inaccurate due to the length of time [elapsed since their epoch]. Also: whom do you trust when you make astrological predictions—Ptolemy alone or one of the others? For the Italians among whom we happen to live hardly use Ptolemy at all in both branches [of the celestial science] (I mean, the theoretical and the practical), but trust more recent [astronomers] more. For they are not satisfied with the Arabic tables alone, which begin from Muḥammad, but utilize many others as well. Therefore, teach me these things clearly. And, if it is possible, order the computational canons (for thus the Latins call the rules for computing) to be copied out and sent to me so that I may compare them with theirs.

Such a comparison of different sets of tables in Greek and in Latin (using Arabic sources and the Hijra Era) are precisely what one finds in the introductory section to the Greek translation of the *Toledan Tables*. If Lapithes was the translator, one can conjecture that John the Astrologer who computed

[18] Hill, *op. cit.*, II, 305 note 2.

[19] For ῥῆγας = King on Cyprus, see J. Darrouzès, "Notes pour servir à l'histoire de Chypre (quatrième article)," Κυπρ.Σπουδ., 23 (1959), 25–56, esp. 39–40.

[20] PG, 148, col. 59; cf. R. Guilland, *Correspondence de Nicéphore Grégoras* (Paris, 1927), 280–81.

the mean longitudes of the planets on 23/24 April and 27/28 April of 1340 (folio 38v) was a Latin astronomer and astrologer at Hugh's court, though I have found no further reference to him.

The introductory section consists of a series of short and unconnected, but generally intelligent, comments on a variety of astronomical topics. The author demonstrates a knowledge of Ptolemy's *Almagest*, of the *Handy Tables* of Theon, and of the *Alfonsine Tables* as well as of the *Toledan Tables*; in fact, he prefers tables of mean planetary motions for twenty-five collected Egyptian years, as in the *Handy Tables*, rather than for thirty collected Arab years, as in the *Toledan Tables* (folios 28–28v and 30–32). Moreover, he realizes that many of the parameters of the *Handy Tables* are embedded in the *Toledan Tables*, as the marginalia on folios 42–104v often indicate. And he bothers to provide instructions only for computing planetary longitudes with the *Toledan Tables* (folios 39–41v), leaving the other tables useless to anyone without a sound knowledge of astronomy. These characteristics of the work completely agree with the hypothesis that Lapithes undertook this translation for the sake of comparing the Latins' Arab-influenced tables with Ptolemy, not in order to provide Byzantine astronomers with another set of tables which did not demonstrably improve upon the *Handy Tables*.

One consequence of this conclusion is that the translation was never copied and that the first part of Vaticanus graecus 212 is an autograph of George Lapithes. That it is the autograph of the translator is clear from the star-catalogue and geographical list (folios 84v and 85), the several headings of tables in Latin, the Latin text on folios 85v–86, and numerous marginalia. One other consequence is that at least one manuscript from Lapithes' astronomical and astrological library survived till the middle of the fifteenth century, when it was available for purchase on Crete; one can hope, then, that other codices of this same provenance will eventually be identified. Finally, it is also likely that the brief texts on the astrolabe copied on folios 1–25v by the hand that wrote the *Toledan Tables* were composed by George Lapithes.

Lapithes, assuming still that he was both translator and scribe, did not fill in all the space available to him, especially in the introductory section. Someone, perhaps Laudivius, has written some alchemical recipes in Latin on folios 27v and 28v.[21] Another, later hand has scribbled Latin headings to some of the tables; I do not record these, though I have provided copies of all the notes in Latin written by the translator, whose hand is easily identifiable from the star-catalogue and the geographical list. At the bottom of folio 40v, in a very sloppy hand, is written: ἐμπρῶσθεν ἐμοῦ τοῦ νοταρηωῦ καὶ κίρις τωῦ παπαιῆοανωῦ τοῦ ηρομονάχου.

In the following pages I transcribe, without corrections, the text of each part of the introductory section, and offer brief comments to elucidate their meaning. For the *Toledan Tables* I give references to the very thorough analysis recently published by Toomer, and already referred to above, adding

[21] A photograph of folio 27v is given in Babinger, *op. cit.*, pl. II.

the titles and headings of the individual tables, any discrepancies from Toomer's descriptions that I have noted, and the marginalia. This should provide adequate information concerning the character of this Byzantine translation; its actual entries in the tables should find their proper place in a critical edition of the Latin version, if that arduous task is ever undertaken and brought to completion.

Folio 26. Κανόνιον τῆς διαφορᾶς τῶν χρόνων τῶν ἐπισήμων προσώπων.

τὰ πρόσωπα	ἀρχαὶ τῶν ἐτῶν ἑκάστου	ἔτη Ῥωμαϊκά	ἡμέραι
1. ἀπὸ Ἀδὰμ ἕως Ναβονασσάρου	ἀρχῆς Σεπτεβρίου	,δψξα	ροζ[1]
2. ἀπὸ Ναβονασσάρου ἕως Φιλίππου	ἀρχὴ πρώτη τοῦ Θώθ, ἦν δὲ κε' Φεβρουαρίου	υκα	σξ[2]
3. ἀπὸ Φιλίππου ἕως Χριστοῦ	ἀρχὴ πρώτη Θώθ, ἦν δὲ ιβ' Νοεβρίου	τκδ	ν
4. ἀπὸ τοῦ Χριστοῦ ἕως τοῦ Ἀλφαώς	ἀρχὴ πρώτη Ἰαννουαρίου	,ασνα	ρνα[3]
5. ἀπὸ Ἀδὰμ εἰς Φίλιππον	ἀρχὴ Σεπτεβρίου	,ερπδ	οβ
6. ἀπὸ Ἀδὰμ εἰς Χριστόν	Σεπτεβρίου	,εφη	ρκβ
7. ἀπὸ Ἀδὰμ εἰς Ἀλφαώς	Σεπτεβρίου	,ςψνθ	σογ
8. ἀπὸ Ναβονασσάρου ἕως Χριστοῦ	πρώτη Θώθ, κε' Φεβρουαρίου	ψμς	τι
9. ἀπὸ Ναβονασσάρου εἰς Ἀλφαώς		,αϡϛη	ϛς
10. ἀπὸ Φιλίππου ἕως Ἀλφαώς	πρώτη Θώθ, Νοεβρίου ιβ'·		
	τέλος ὅλον Μάϊον	,αφος	σα
11. ἀπὸ Χριστοῦ εἰς Μωάμεδ	ἀρχὴ Ἰαννουαρίου·		
	τέλος ιδ' Ἰουλίου	χκα	ρ ϛε
12. ἀπὸ Ἀδὰμ εἰς Μωάμεδ	ἀρχὴ Σεπτεβρίου·		
	τέλος ιδ' Ἰουλίου.	,ϛρκϑ	τιζ

Marginalia on f. 26

1. dies anni 365 solaris.
2. ποιοῦσιν ἔτη Αἰγύπτια υκγ σῷα καὶ συμφωνοῦσιν αἱ ψηφηφορίαι.
3. dies anni 365 ¼ solaris.

Commentary

This table of differences between eras is closely related to that of the *Alfonsine Tables* (*Tabule Astronomice Divi Alfonsi*, ex officina litteraria Petri Liechtenstein, Anno 1518 Venetiis, f. 33), which the translator has certainly read; another table more closely related to the *Toledan Tables* is found on folio 36. In column 1 the eras are named; I add their epoch dates in the Julian calendar; and the astronomical tables in which the era was used:

a	Adam = κόσμου κτίσις	1 September – 5508
b	Nabonassar (*Almagest*)	26 February – 746
c	Philip (*Handy Tables*)	12 November – 323

e	Christ	1 January 1
f	Muḥammad (*Toledan Tables*)	15 July 622
h	Alfonso (*Alfonsine Tables*)	1 June 1252

In column 2 the beginnings of the years are listed according to the first era in column 1; that of the era of Nabonassar is mistakenly given as 25 February. In columns 3 and 4 the intervals in Julian years and days are noted. Of these the following are identical with the printed *Alfonsine Tables*:

8. From b to e. The *Alfonsine Tables* have 746 years 310 days.
9. From b to h. The *Alfonsine Tables* have 1998 years 96 days.
11. From e to f. The *Alfonsine Tables* have 621 years 195 days.

The other values are either from a different copy of the *Alfonsine Tables* than that used in the printed version (2, 3, 4, and 10) or were independently computed by the translator (1, 5, 6, 7, and 12). I tabulate below the correct intervals in Julian years and days:

1. From a to b. 4761 Julian years (not Egyptian, as the marginal note asserts) and 177 days (using 25 February as epoch, as also in the other entries involving the era of Nabonassar).
5. From a to c. 518*5* Julian years and 72 days.
6. From a to e. 5508 Julian years and 122 days.
12. From a to f. 6129 Julian years and 317 days.
7. From a to h. 6759 Julian years and 273 days.
2. From b to c. 42*3* Julian years and 260 days (the marginal note is wrong; the *Alfonsine Tables* have 423 years and 265 days).
8. From b to e. 746 Julian years and 310 days.
9. From b to h. 1998 Julian years and 96 days.
3. From c to e. 32*3* Julian years and 50 days (the *Alfonsine Tables* have 323 years and 51 days).
10. From c to h. 157*4* Julian years and 201 days (the *Alfonsine Tables* have 1574 years and 202 days).
11. From e to f. 621 Julian years and 195 days.
4. From e to h. 1251 Julian years and 151 days (the *Alfonsine Tables* have 1251 years and 152 days).

It is apparent from 3 and 5 that the epoch of the era of Philip was assumed to be 12 November – 324; this is used in the computations on folios 26v–27 and 29–29v. But from 2 and 10 it seems that 12 November – 325 was regarded as the epoch.

Folio 26v

Περὶ τοῦ εὑρεῖν τὰ Αἰγύπτια ἔτη ἀπὸ Ναβονασσάρου ἄχρι τῆς ἐπιζητουμένης ἡμέρας.

Ληπτέον τὰ ἀπὸ κτίσεως κόσμου συμπεπληρωμένα ἔτη καὶ ἐξ αὐτῶν ἀφαιρετέον ἔτη ,δψξα. εἶτα τοῦ ἐνεστῶτος ἔτους ἀρκτέον ἀπὸ ἀρχῆς Σεπτεβρίου ἀριθμεῖν τὰς ἡμέρας τῶν μηνῶν καθεξῆς ἕως τῆς ἐπιζητουμένης ἡμέρας. καὶ τῶν γινομένων ἀφαιρετέον ἡμέρας ροζ καὶ τοῖς λοιποῖς προσθετέον τὰς τετραετηρίδας, καὶ τὰς γινομένας ἀφελόντα τξε εἴπερ ἔχει τὰς λοιπὰς δοτέον ἑκάστῳ μηνὶ ἡμέρας λ ἀρξάμενον ἀπὸ τοῦ Θώθ. καὶ τὰς λειπομένας ἥττους τῶν λ ἡμέρας λεκτέον εἶναι τοῦ μηνὸς ἐκείνου.

Ὑποκείσθω δ'ὡς ἐν ὑποδείγματι χρόνος ἀναδοθεὶς Ἀπριλλίου ια' ὥρᾳ νυκτερινῇ τρίτῃ τοῦ ἔτους ἀπὸ Ἀδὰμ ,ϛωμϑ. ἐπεὶ οὖν ἀτελές ἐστι τὸ ἓν ἔτος, ληπτέον ἔτη ,ϛωμη πεπληρωμένα ἄχρι τῆς ἐσχάτης τοῦ παρελθόντος αὐτοῦ, ἐξ ὧν ἀφαιρουμένων ,δψξα[a] μένει ,βπζ. εἶτα ἀπὸ τῆς ἀρχῆς Σεπτεβρίου ἄχρι τῆς ια' Ἀπριλλίου ἡμέραι εἰσὶ σκγ, ὧν ἀφαιρουμένων ροζ μένει μς· αἷς προσθετέον τὰς δ' αἳ εἰσιν ἐν τοῖς ,βπζ ἔτεσιν ἡμέραι φκα. ὁμοῦ φξζ, ὧν ἀφαιρεθέντων τξε μένει σβ, αἵπερ ποιοῦσι τριακοντάδας ϛ ἡμέρας κβ. ἕξομεν οὖν εἰς τὸν ἀναδοθέντα χρόνον ἔτη Αἰγύπτια ἀπὸ Ναβονασσάρου ,βπη μῆνας ϛ ἡμέρας κβ ὥρας καιρικὰς ϑ — ἡμερινὰς μὲν ϛ, νυκτερινὰς δὲ γ.

a ,ε,δψξα MS.

Commentary

This rule follows directly from relation 1 on folio 26 and from the fact that in that table Julian years of 365 $^1/_4$ days are used, whereas the tables on folios 30–31 use Egyptian years of 365 days. A table of Egyptian months is to be found on folio 32^v. The date of the example is 11 April 1341, as it is also in the example to the next rule. The epoch of the era of Nabonassar is correctly taken to be noon.

Folios 26^v–27

Τὰ δὲ ἀπὸ Φιλίππου βουλόμενος εὑρεῖν, λαβὼν τὰ ἀπὸ κτίσεως κόσμου ἄφελε ,ερπδ μόνον· τὰς γὰρ οβ ἡμέρας τὰς ἐν τῷ κανονίῳ τῶν ἐτῶν εὑρισκομένας οὐκ ἀφαιρεῖς διὰ τὸ ἀναπληροῦσθαι ἀπὸ τῶν τετραετηρίδων τῶν μέχρις αὐτοῦ. εἶτα τὰς ἡμέρας ἀριθμητέον ἀπὸ τῆς κϑ' Αὐγούστου ἄχρι τῆς ἐπιζητουμένης ἡμέρας, αἷς προσθέντα τὰς τετραετηρίδας ἀπὸ τοῦ ϛ' ἔτους Αὐγούστου, ἀφελόντα τξε ἐὰν ἔχῃ, τὰς λοιπὰς δοτέον ἑκάστῳ μηνὶ ἡμέρας λ ἀρξάμενον ἀπὸ τοῦ Θὼϑ.

Ὑποκείσθω δὲ προειρημένος χρόνος ια' Ἀπριλλίου ὥρᾳ νυκτερινῇ γ'. ἀφελόντα οὖν [f. 27] τῶν ,ϛωμη ,ερπδ, μένει ,αχξδ. τοὺς δὲ μῆνας οὕτως. ἐπεὶ γὰρ ἀπὸ τῆς κϑ' τοῦ Αὐγούστου ἄχρι τῆς ια' Ἀπριλλίου ἡμέραι εἰσὶ σκς, αἷς προστεθέντων τῶν τετραετηρίδων ἀπὸ τοῦ ϛ' ἔτους Αὐγούστου, ἡμερῶν τμα, γίνονται ἡμέραι φξζ, ἐξ ὧν ἀφαιρουμένων ἐνιαυτὸν ἕνα, ἡμέρας τξε, τὰς λειπομένας σβ ποιοῦμεν μῆνας ϛ ἡμέρας κβ. ἀρξάμενοι οὖν ἀπὸ τοῦ Θὼϑ ἔχομεν μῆνα Φαμενὼϑ ἡμέρας κβ ὥρας ἡμερινὰς ϛ καὶ νυκτερινὰς γ καὶ ἔτη Αἰγύπτια ,αχξε.

Commentary

This rule for converting a date expressed in the calendar of the Byzantine era of Creation into one expressed in that of the era of Philip follows from relation 5 (which is in error by one year) on folio 26 and from the fact that 1 Thoth fell on 12 November Julian in – 323 and on 29 August Julian with the reform of Augustus in – 29; Julian years had begun to be used in – 44, under Julius Caesar. However, since the interval between 29 August and 12 November is 75 days, the text correctly subtracts 300 Egyptian years from the date in the era of Philip before counting the intercalary days of the Julian years; this means that one begins to count the intercalary days on 29 August – 24, which is the beginning of the sixth year of the era of Augustus. See Theon on the *Handy Tables*, in M. L'Abbé Halma, *Commentaire de Théon d'Alexandrie sur le livre III de l'Almageste de Ptolemée* (Paris, 1822), 30 and 32.

Folio 27

Ἐπεὶ δὲ δεῖ καὶ τὰς ὥρας τὰς καιρικὰς διακρῖναι πρῶτον μὲν εἰς ἰσημερινὰς οὕτως· ὑποθέμενοι τὴν τοῦ Ἡλίου μοῖραν εἶναι τὴν ἐσχάτην τοῦ Κριοῦ, τὴν δὲ διαμετροῦσαν ταύτῃ τὴν λ′ τοῦ Ζυγοῦ. ταύτας εἰσαγαγὼν εἰς τὸ τῶν ἀναφορῶν κανόνιον τοῦ τετάρτου κλίματος, εὗρον παρακειμένους ὡριαίους χρόνους τῇ μὲν λ′ τοῦ Κριοῦ χρόνους ις κς, τῇ δὲ λ′ τοῦ Ζυγοῦ ιγ λδ. καὶ πολλαπλασιάσας τὰς μὲν ταῖς ἓξ ὥραις ἡμεριναῖς εὗρον ϛη ͵ι′, τὰς δὲ ταῖς νυκτεριναῖς τρισὶν εὗρον μ ͵ε′ · ὁμοῦ χρόνοι ρλϑ ε′ ι′, ἃς μερίσας παρὰ τὰ ιε εὗρον ὥρας ἰσημερινὰς ϑ ε′ ἔγγιστα. ἐπεὶ δὲ τῆς Ἀλεξανδρείας ἡ Κύπρος ἀνατολικωτέρα ἐστὶ μοίρας ϛ, ταύτας μερίσας παρὰ τὰ ιε εὗρον ὥρας πέμπτα δύο, ὧν ἀφαιρεϑέντων λείπεται ὥραι η ͵ε′ ι′. ἐπεὶ δὲ δεῖ καὶ πρὸς τὰ ὁμαλὰ νυχϑήμερα αὐτὰς διακρῖναι, εἰσαγαγὼν τὴν τοῦ Ἡλίου μοῖραν, τὴν λ′ τοῦ Κριοῦ, εἰς τὸ ἐπ᾽ ὀρϑῆς τῆς σφαίρας κανόνιον εὗρον ὡριαῖα ξ′ ια ιγ, ὧν τὸ δ′ γ ἔγγιστα, ὅπερ ἐστὶ κ′ · ὃ προσϑεὶς ταῖς διακριϑείσαις ἡμέραις η ͵ε′ ι′, γίνονται ὥραι ἰσημεριναὶ η ͵ε′ ι′ κ′.

Commentary

In this example, the Sun's longitude is assumed to be 30^0, which indicates a Julian date of about 19 April; but the time of day is the third seasonal hour of the night, as it was in the preceding two examples for 11 April. The author has used the *Handy Tables* (M. L'Abbé Halma, *Tables manuelles astronomiques* [Paris 1822–25]), in which for the fourth climate (in which Cyprus lies) one does find the ὡριαῖοι χρόνοι opposite Aries 30^0 to be 16;26 and opposite Libra 30^0 to be 13;34 (II, pp. 26 and 30). These are multiplied respectively by 6 seasonal hours and 3 seasonal hours to give 98;36 ($= 98 + {}^1/_2 + {}^1/_{10}$) and 40;42 ($= 40 + {}^1/_2 + {}^1/_5$), whose sum is 139;18 ($= 139 + {}^1/_5 + {}^1/_{10}$) time-degrees; divided by 15 these result in 9;17, ... ($\approx 9\ {}^1/_5$) equinoctial hours. This is the time at Alexandria; but Cyprus (actually Salamis) was situated by ancient geographers including Theon (*Commentaire*, 119 and 124) exactly 6^0 East of Alexandria, which equals 0;24 ($= {}^2/_5$) equinoctial hours. Finally, to account for the equation of time, the author looks in the table of ascensions in sphaera recta (I, pp. 148–54) and finds 0;11,13 opposite Aries 30^0; divided by 0;4 degrees per minute, these result in approximately 3 minutes or ${}^1/_{20}$ of an equinoctial hour. The final result, then, is:

$$\begin{array}{l} 9\ {}^1/_5 \\ \underline{-\ {}^2/_5} \\ 8\ {}^4/_5 \end{array} \quad \begin{array}{l} \text{equinoctial hours from noon.} \\ = 8 + {}^1/_2 + {}^1/_5 + {}^1/_{10} \\ \quad + {}^1/_{20} \\ \hline 8 + {}^1/_2 + {}^1/_5 + {}^1/_{10} + {}^1/_{20} = 8;51 \text{ hours} \end{array}$$

Folios 28–28^v

Ἰστέον ὅτι οἱ κανόνες τῶν ἀστέρων πρὸς ἀλλήλους κατὰ μὲν τοὺς τῆς διορϑώσεως κανόνας οὐ διαφεροῦσιν εἰ μή τι γραφέως ἁμάρτημα, κατὰ δὲ τὰς μέσας κινήσεις τῶν μὲν κέντρων τῶν ἀστέρων αὖϑις οὐ διαφέρουσιν, τῶν δὲ κέντρων τῶν ἐπικύκλων διαφέρειν δοκοῦσιν ὅτι οἱ μὲν τῆς Μεγάλης Συντάξεως συλλαμβάνουσι καὶ τὴν τῶν ἀπογείων κίνησιν, οἱ δὲ Πρόχειροι καὶ τῶν Ἀράβων οὔ[1], διὸ καὶ ἐν ταῖς ψηφηφορίαις αὐτῶν προστίϑενται, ἐν μὲν τοῖς Προχείροις

διὰ τῆς καρδίας τοῦ Λέοντος, ἐν δὲ τοῖς Ἀραβικοῖς αὐτὴ καθ' αὑτην. ἔτι δὲ διαφέρουσι κατὰ τὰς ἐποχάς, τοῦτο μὲν τῷ[a] ἐν διαφόροις εἰλῆφθαι χρόνοις διαφόρους εἶναι ταύτας κατ' ἄλλον καὶ ἄλλον χρόνον, τοῦτο δὲ τῇ τάξει τῶν συνθέντων τοὺς κανόνας, ὅτι ἐν μὲν τῇ Συντάξει οὐκ ἔγκεινται τοῖς κανόσιν αἱ ἐποχαὶ ἀλλ' ὕστερον προστίθενται, ἐν δὲ τοῖς Προχείροις ἔγκεινται αἱ ἀπὸ τῶν ἀπογείων μόναι, τὸ δὲ ἀπὸ Κριοῦ ἕως τῆς καρδίας τοῦ Λέοντος καὶ ἐκ ταύτης ἕως τοῦ ἀπογείου ὕστερον προστίθεται μετὰ τὴν διευκρίνησιν, ἐν δὲ τοῖς Ἀραβικοῖς ἔγκεινται τοῖς κανόσιν ἡ ἀπὸ τοῦ Κριοῦ ἐποχή, διὸ πρῶτον ἀφαιρεῖται τὸ ἀπόγειον καὶ οὕτως εἰσάγεται εἰς τὸν κανόνα τῆς διορθώσεως, καὶ μετὰ τὴν διόρθωσιν αὖθις προστίθεται. ἔτι δὲ διαφέρουσιν οἱ κανόνες καὶ κατὰ τὸν χρόνον, οὐ μόνον τῷ ἀπὸ ἄλλης καὶ ἄλλης ἤρχθαι ἀρχῆς, ἀλλὰ καὶ τῷ τοὺς μὲν εἶναι ἡλιακούς (ἤτοι τὸ ἔτος ἡμέρας τξε δ' ὥσπερ οἱ τοῦ Ἀλφούνς), τοὺς δὲ σεληνιακοὺς ὥσπερ τὰ τῶν Ἀράβων (τὸ γὰρ ἔτος αὐτοῖς ἡμέρας ἔχει τνδ λεπτὰ κβ), τὰ δὲ εἶναι Αἰγύπτια ὥσπερ τὰ τῆς Μεγάλης Συντάξεως καὶ τῶν Προχείρων.

Τρεῖς οὖν αὗται τῆς διαφορότητος τῶν κανόνων αἰτίαι — ὅ τε χρόνος καὶ αἱ ἐποχαὶ καὶ ἡ τοῦ ἀπογείου κίνησις ἢ συνειλημμένη ἢ οὔ. δοκεῖ δέ μοι κάλλιστον εἶναι καὶ [f. 28v] ἁπλούστατον καὶ ὁμαλώτατον τὸ εἶναι τὰ μὲν ἔτη Αἰγύπτια διὰ τῶν τετραετηρίδων ἰσούμενα, τὰς δὲ ἐποχὰς μὴ συγκεῖσθαι τοῖς κανόσιν ἀλλ' ἰδίᾳ γεγράφθαι ἑκατέραν χώρις, τήν τε ἀπὸ Κριοῦ ἕως τοῦ ἀπογείου καὶ τὴν ἀπὸ τῶν ἀπογείων κίνησιν, ἵνα αὕτη προστιθῆται τῇ μέσῃ κινήσει πρὸ τῆς διορθώσεως, ἐκείνη δὲ μετὰ τὴν διόρθωσιν — ἡ τοῦ ἀπογείου δηλαδή — τὴν δὲ τοῦ ἀπογείου κίνησιν μὴ συγκεῖσθαι ταῖς μέσαις κινήσεσιν, ἀλλ' ὕστερον μετὰ τὴν διόρθωσιν προστίθεσθαι. οὕτω γὰρ ἐχόντων τῶν κανόνων, τό τε ψηφηφορεῖν ῥᾷον καὶ τὰ ἐν αὐτοῖς ἐνίοτε τῶν γραφέων σφάλματα τῇ παραθέσει ἐλέγχειν ῥᾴδιον, νῦν δὲ χαλεπόν.

Marginalium on f. 28

1. οἱ Πρόχειροι ἐν τῇ τοῦ Ἡλίου μόνῃ συλλαμβάνουσι τὴν κίνησιν τοῦ ἀπογείου.

a τῷ τῷ MS.

Commentary

The author is correct in his comparisons of the *Almagest*, the *Handy Tables*, and the *Arabic* (or *Toledan*) *Tables* with respect to the mean motions of the planets; he is also right in stating that the *Alfonsine Tables* use a solar year of $365\,{}^{1}/_{4}$ days (*Tabule Astronomice*, 39). He clearly is a competent astronomer. This impression of competence is increased by his choice of Egyptian years with the mean motions measured from a fixed Aries 0^{0}, to be corrected for precession—i.e., the "motion of the apogee"—after the mean sidereal longitudes have been corrected for the equation of the center. It is difficult, in the circumstances, to understand his interest in translating the *Toledan Tables* except for the purpose of comparison.

Folios 29–29v

Δεῖ γινώσκειν ὅτι, βουλόμενοι τὰς ἐποχὰς τῶν κανονίων τῆς Τολέτας βεβαιώσασθαι, εἰ ὀρθαί εἰσιν, ἐλάβομεν τὸν χρόνον ἀπὸ Φιλίππου τοῦ Ἀρ δαίου μέχρι τοῦ Μωάμεθ, καθ' ὃν χρόνον συνέστησαν τὰ τῆς Τολέτας κανόνια, καὶ εὕρομεν ἡλιακὰ ἔτη ϡμε ἡμέρας σμε· αἷς προσθέντες τὰς τετραετηρίδας σλς ἔχομεν ἡμέρας υπα, ὧν ἀφελόντα ἡμέρας τξε εἰς ἐνιαυτὸν ἕνα, ὃν προστίθεμεν τοῖς ἔτεσιν, λοιπαὶ ἡμέραι ρις. χρόνος ἄρα Αἰγύπτιος ἀπὸ Φιλίππου ἕως Μωάμεδ ἔτη ϡμς μῆνες γ ἡμέραι κς, ἃς εἰσαγαγόντες εἰς τοὺς Προχείρους εὕρομεν μέσα κινήματα κατὰ τὴν ἀρχὴν τοῦ Μωάμεδ τὰ δηλούμενα ἐν ταῖς ὑποτεταγμέναις ψηφηφορίαις, αἷς ὑπετάξαμεν τὰς τοῦ Μωάμεδ ἐποχὰς καὶ τὰς εὑρισκομένας διαφορὰς ἀμφοῖν.

χρόνοι	Ἥλιος	ἀπόγειον Σελήνης	Σελήνης κέντρον ἐπίκυκλον	κέντρον Σελήνης	ἔκκεντρος Κρόνου	κέντρον τοῦ ἀστέρος Κρόνου
ϡκς	σϙζ ιζ	τκη λ	τβ λβ	ο ζ	τμη κα	ρλς μϑ
κ	τνε η	οζ ιϑ	ρμδ νε	τλδ κβ	σμδ ις	ρι μ
μῆνες γ	πη μβ	σπη κη	λδ κ	ϙε να	γ α	πε μβ
ἡμέραι κς	κδ λη	σπ η	σμϑ λβ	τκς λζ	ō ν	κγ μη
	α	β	β	α	α	β
	με με	σνδ κε	ια ιϑ	ρς νζ	σλς κη	τνς νϑ
	πρόσθες τὸ		ἄφελε τὸ		πρόσθες	
	ἀπὸ Κριοῦ		ἀπόγειον		ταῦτα	
	ξε λ		προσθεὶς		καρδίᾳ	
	ὁμοῦ		κύκλον		Λέοντος	
	ρια ιε		σνδ κε		ρκζ κε	
			λοιπά		ἐπίληψις	
			ριϛ νδ		⟨ρ⟩ι λ	
					ὁμοῦ	
					ριδ κγ	
	ἐποχὴ τοῦ		ἐποχὴ τοῦ		ἐποχὴ	
	Μωάμεδ		Μωάμεδ		Μωάμεδ	
	ριγ μα		ρκ νη		ριε να	
	διαφορά		διαφορά		διαφορά	
	β κς		δ δ		α κη	

[f. 29v]

χρόνοι	ἔκκεντρος Διός	ἔκκεντρος Ἄρεος	κέντρον Ἀφροδίτης	κέντρον Ἑρμοῦ
ϡκς	σξζ ιη	ρξβ λβ	ρν μζ	οϒ νε
ἁπλᾶ κ	σμς νς	σκε κς	ρπ λα	τνη νδ
μῆνες γ	ζ κϑ	μζ ι	νε κϑ	σοϑ λς
ἡμέραι κς	β ε	ιϒ ϛ	ιε κε	οζ μ
	α	α	β	γ
	ρξϒ μη	πη ιδ	μβ ιβ	ο ε
	καρδία	καρδία		
	Λέοντος	Λέοντος		
	ρκζ κε	ρκζ κε		
	ἐπίληψις	ἐπίληψις		
	λη λ	τνδ ō		
	ὁμοῦ πάντα	ὁμοῦ		
	τκϑ μϒ	ση λϑ		
	τοῦ Μωάμεδ	τοῦ Μωάμεδ	τοῦ Μωάμεδ	τοῦ Μωάμεδ
	τλα λϑ	σια κδ	με κη	οϒ μς
	διαφορά	διαφορά	διαφορά	διαφορά
	α νς	β με	γ ις	γ μα

Marginalium on f. 29v

Εἰδέναι δεῖ ὅτι, διὰ τὸ μὴ ἐγκεῖσθαι τοῖς κανονίοις τῆς Τολέτας τάς τε κινήσεις τῶν ἐπικύκλων τῶν ὑπὲρ τὸν Ἥλιον ἀστέρων καὶ τὰς κινήσεις τῶν ἐκκέντρων Ἀφροδίτης καὶ Ἑρμοῦ, οὐδ' ἐνταῦθα τέθεινται.

Commentary

The time between the epochs of the era of Philip and that of the Hijra is actually 945 Egyptian years 116 days; but cf. the commentary to folio 26. Since the *Handy Tables* begin the tables of mean motion with the current year 1, the error is cancelled. The readings of the *Handy Tables* are correct save that for 20 years' motion of the center of the Moon's epicycle the printed text has 144;54^0 instead of 144;55^0; for 20 years' eccentric motion of Jupiter one should have 246;36^0 instead of 246;56^0; the longitude of Regulus should be 127;21^0 instead of 127;25^0; and for the ἐπίληψις of Mars the printed text has 353^0 instead of 354^0, but in adding, the Byzantine computer used the correct number. The rest of his additions are all correct. The epochs according to the *Toledan Tables* are found in the tables on folios 42–67 (the seconds are not considered). The differences are also correctly computed; but the author draws no conclusions as to which set of epoch-longitudes he believes to be correct.

Folios 30–32

These folios contain the mean motion tables promised on folio 28^v. The order is:

Folios 30–30^v. Table of mean motions in 25 collected Egyptian years for Saturn, Jupiter, Mars, Venus, and Mercury (the years are 25, 50, 75, 100, 200, 400, 500, 1000, 1500, 1600, 1650, 1675, 1700, 2000, 2050, and 2075; for the superior planets the motions of the κέντρον ἐπικύκλου and of the κέντρον αὐτοῦ τοῦ ἀστέρος are tabulated, for the inferior planets only the latter).

Folio 31. Similar table of the mean motion of the Sun and the eccentric circles of Venus and Mercury in 25 collected Egyptian years (the years are 25, 50, 75, 100, 200, 400, 500, 1000, 1500, 1600, 1650, 1675, 1700, 2000, 2050, and 2075) and in 1 to 25 single Egyptian years (those for years 26 and 27 are added in European numerals).

Folios 31^v–32. Table of the mean motions of the same bodies as are included in the tables on folios 30–30^v in 1 to 25 single Egyptian years.

These tables are derived directly from the mean motion tables in the *Almagest* (III 2 and IX 4) with the thirds and further sexagesimal fractions ignored, save in the case of the Sun, whose motion is given to fourths; for years 19 to 25 the motion for a single year is added to the motion of the preceding year, with the occasional addition of 1 in the last place. The author has done a reasonably accurate job of copying, adding, and multiplying, but nothing else. It is not worthwhile to reproduce his tables; I give here only copies of his marginalia.

Folio 30

Ἰστέον ὅτι ὁ κανὼν τοῦ Κρόνου ἔχῃ πλέον ἐν κε ἔτεσιν λεπτὸν πρῶτον ἕν, ὅπερ ἐστὶ σφάλμα · συνάγεται δὲ ἐν ἔτεσι ,αφ μοῖρα α.

Commentary

According to the *Almagest*, the motion of Saturn in 25 years is 305;34,58,32, 42,36,15^0, and the Byzantine table correctly has 305;34,58^0. However, the computer has taken into consideration the 0;0,0,32^0 (he uses 0;0,0,31^0) of the *Almagest*, so that his entry for 50 is 251;9,57^0 ($\approx$ 305;34,58,31^0 · 2 = 251;9, 57,1^0), and for 1500 (= 25 · 60) is 334;58,31^0 (= 305;34,58,31^0 · 60).

Folio 30^v

Ὑπεροχὴ ἣν ὑπερέχει ἡ μέση κίνησις τῆς Συντάξεως Πτολεμαίου τῆς ἐν τοῖς Προχείροις κανόσιν ἐν χιλίοις ἔτεσιν Αἰγυπτίοις ἤτοι τοῦ κέντρου τοῦ ἐπικύκλου.

Κρόνου	μοῖραι ι
Διός	μοῖραι ια
Ἄρεος	μοῖραι ι

ἱστέον ὅτι τὰ μέσα κινήματα ἀμφοτέρων τῶν συντάξεων, τῆς τε Μεγάλης Συντάξεως καὶ τῶν Προχείρων κανόνων, σχεδὸν συμφωνεῖ, διαφέρει δὲ μόνον κατὰ τὴν κίνησιν τῶν γ ἀστέρων ἤτοι ... (the rest is clipped off with the margin).

Commentary

The difference of course is the Ptolemaic amount of precession, or 1^0 in each 100 years; it should be 10^0 for each of the planets, not 11^0 for Jupiter; and it applies to the centers of the epicycles of the two inferior as well as to the three superior planets.

Folio 31^v

Ἰστέον ὅτι ἐν τοῖς κανόσι τῆς Μεγάλης Συντάξεως τὰ μήκη τοῦ Ἡλίου καὶ τῶν ε ἀστέρων περιέχουσι τὴν κίνησιν τοῦ ἀπογείου καὶ οὐ δεῖ ψηφηφοροῦντα προστιθέναι αὐτήν, τοῖς δὲ κανόσι τῶν Ἀράβων δεῖ προστιθέναι αὐτὴν ὅτι οὐ πρόσκειται, τοῖς δὲ Προχείροις οὐ πρόσκειται μέν, προστίθεται δὲ διὰ τῆς καρδίας τοῦ Λέοντος.

Folio 32^v

πλάνητες	♄	♃	♂	♀	☿
ἐκκεντρότητες οἵων ἡ διάμετρος τοῦ ἐκκέντρου ρκ.	γ κε	β με	ς ō	α ιε	ε κς
διάμετροι τῶν ἐπικύκλων οἵων ἡ διάμετρος τοῦ ἐκκέντρου ρκ	ιγ ō	κγ ō	οϑ ō	πς κ	με ō

ἐποχαὶ κατὰ τὸ πρῶτον ἔτος Ναβονασσάρου πρώτῃ τοῦ Θώθ, κε' Φεβρουαρίου ἔτους ἀπὸ Ἀδὰμ ,δψξβ.

τὰ ἀπόγεια τῶν ἐκκέντρων		ἐποχαὶ τοῦ κέντρου τοῦ ἐπικύκλου ἀπὸ τῶν ἀπογείων τῶν ἐκκέντρων		κίνησις τῶν ἀστέρων ἀπὸ τῶν ἀπογείων τῶν ἐπικύκλων
ἡ ἀπὸ τοῦ Κριοῦ διάστασις	ἡ μοῖρα ἐν ᾗ ἐστιν	ἡ ἀπὸ τοῦ ἀπογείου διάστασις	ἡ μοῖρα ἐν ᾗ ἐστιν	

♄	σκδ ι	♏ ιδ ι	οβ λγ ♑ κς μγ	λδ β
♃	ρνβ ♑	♍ β ♑	λβ λβ ♎δ μα	ρμς δ
♂	ρς μ	♋ ις μ	σνς νβ ♈ γ λβ	τκζ ιγ
☉	μς ι	♉ ις ι	σπδ λε ♓ ō με	οα ζ
☿	ρπα ι	♎ α ι	ρμϑ λϑ ♓ ō με	κα νε

μῆνες	μῆνες	μῆνες	μῆνες
Ῥωμαίων	Αἰγυπτίων	Ῥωμαίων	Αἰγυπτίων
Σεπτέβριος	Θώϑ	Μάρτιος	Φαμενώϑ
Ὀκτώβριος	Φαωφί	Ἀπρίλλιος	Φαρμουθί
Νοέβριος	Ἀθύρ	Μάϊος	Παχών
Δεκέβριος	Χοιάκ	Ἰούνιος	Παῦνί
Ἰαννουάριος	Τυβί	Ἰούλιος	Ἐπιφί
Φεβρουάριος	Μεχίρ	Αὔγουστος	Μεσωρί

Commentary

The eccentricities and diameters of the epicycles of the planets are derived from *Almagest* XI 10, which lists the radii of the epicycles and the furthest and least distances of the centers of the epicycles from the center of the earth, measured in units of which there are 120 in the diameter of a circle. Mercury has a greatest distance of 69 parts, least of 55;34 parts; the author has incorrectly subtracted the latter from 60 to get his 5;26 parts. The epoch positions are derived from the headings of the tables of mean motions in collected 18 Egyptian years in *Almagest* IX 4. The only error is that the elongation between mean Mercury and its apogee should be 149;35^0 rather than 149;39^0.

Folio 33

ἐποχαὶ πλανήτων κατὰ τὸ πρῶτον ἔτος Φιλίππου τοῦ Ἀριδαίου κατὰ τὴν πρώτην τοῦ Θὼϑ μεσημβρίας, ἥτις ἦν ιβ′ τοῦ Νοεβρίου μηνὸς ἔτους ἀπὸ Ἀδὰμ ἐνισταμένου ,ερπε′.

Ἡλίου μῆκος ἀπόγειον	Σελήνης ἀπόγειον τοῦ ἐκκέντρου	Σελήνης κέντρον τοῦ ἐπικύκλου ἀπὸ τοῦ ἀπογείου	Σελήνης κέντρον αὐτῆς ἀπὸ τοῦ ἀπογείου τοῦ ἐπικύκλου	βόρειον πέρας
ρξβ κε	τιβ μη	α κε	τνς λδ	σι νϑ

ἐποχαὶ τῶν ε ἀστέρων.

	καρδία Λέοντος ἀπὸ Κριοῦ ριζ νδ	ἐπιλήψεις ἀπὸ τῆς καρδίας τοῦ Λέοντος ἕως ἀπογείων τῶν ἐκκέντρων	τὰ κέντρα τῶν ἐπικύκλων ἀπὸ τῶν ἀπογείων τῶν ἐκκέντρων	τὰ κέντρα τῶν ἀστέρων ἀπὸ τῶν ἀπογείων τῶν ἐπικύκλων
Κρόνου		ρι λ	ρ ϛη μϑ	ρξ μδ
Διός		λη λ	σξβ ō	ρξϑ λβ
Ἄρεος		τνγ ō	ρξδ ν	τιβ ια
Ἀφροδίτης		σ ϛβ λ	ροζ λβ	ρπς νϑ
Ἑρμοῦ		ξζ λ	μβ λ	ρξ μγ

Ταῖς ἐποχαῖς ταύταις ἐὰν προσθῇς ἐνιαύσιον κίνημα καὶ ἀφέλῃς κύκλους, εὑρήσεις τοὺς ἀριθμοὺς τοὺς παρακειμένους τῷ πρώτῳ στίχῳ τῶν Προχείρων κανόνων. ἔστι δὲ τὸ πρῶτον τοῦτο ,ερπε ἀπὸ Ἀδάμ.

Commentary

The epoch adopted for the *Handy Tables* is regarded as 12 November – 324, and the initial positions in the *Handy Tables* as for the beginning of lapsed year 1 or 12 November – 323 (*Handy Tables*, II, 66, 112, and 114). Therefore, the epoch longitudes are found by subtracting the motion for one year from each of these initial positions (*ibid.*, 70, 120, and 122). This procedure is correctly followed by the author, except that the anomaly of Venus should be 216;59^0 instead of 186;59^0 and the elongation of the center of Mercury's epicycle from its apogee should be 42;31^0 instead of 42;30^0. The ἐπιλήψεις from the *Handy Tables* have already been given in the table on folios 29–29^v.

Folio 33^v

ἐποχαὶ τῶν κανόνων τοῦ Ἀλφαὼς ἀρξαμένων ἀπὸ ἀρχῆς Ἰουνίου ἔτους ἀπὸ Χριστοῦ ,ασνβ' ἤτοι παρελθόντων ἐτῶν ,ασνα καὶ μηνῶν ε.

	Ἡλίου	Σελήνης	Κρόνου	Διός	Ἄρεος
μήκους ἀπὸ τῆς ἀρχῆς τοῦ Κριοῦ	οζ λζ	τλς ε	σδ μδ	ις ις	ρπα να
ἀνωμαλίας ἀπὸ τοῦ ἀπογείου τοῦ ἐπικύκλου		ρνβ δ			

Commentary

The epoch longitudes in the printed version of the *Alfonsine Tables* (fols. 40^v–41^v) are:

Sun	*76*;37,12,38,42^0
Moon	336;5,21,11,45^0
Moon's anomaly	250;*51*, 40,9,0^0
Saturn	*264*;44,33,26,0^0
Jupiter	16;16,15,14,0^0
Mars	181;*41*,36,19,0^0

The error with respect to the Sun is probably that of the printed *Alfonsine Tables*, that with respect to Saturn is an omission by the Byzantine author or the scribe of the manuscript of the *Alfonsine Tables* that he consulted. The other errors are not so clearly due to one or the other.

Folio 34

διαφοραὶ διαστημάτων μεταξὺ τῶν πλανητικῶν σφαιρῶν.

μεταξὺ Σελήνης καὶ Ἑρμοῦ	ϑ,ϑφε μίλια
μεταξὺ Ἑρμοῦ καὶ Ἀφροδίτης	λγ,δση
μεταξὺ Ἀφροδίτης καὶ Ἡλίου	ρϑ,ζσν
μεταξὺ Ἡλίου καὶ Ἄρεος	σλβ,ε
μεταξὺ Ἄρεος καὶ Διός	βυπη,β
μεταξὺ Διὸς καὶ Κρόνου	,αψϛ,ϑσν
μεταξὺ Κρόνου καὶ τῆς ἀπλανοῦς	,αωνδ,ασν

τὸ ἥμισυ τῆς διαμέτρου τῆς γῆς ,γσν μίλια

τὸ περιγειότατον διάστημα τῶν πλανητῶν ἑκάστου ἀπὸ τῆς γῆς ἤτοι ἀπὸ γῆς ἄχρι τοῦ περιγειοτάτου αὐτῶν.

τῆς Σελήνης ἀπὸ γῆς	ι,ϑλζ μίλια
τοῦ Ἑρμοῦ ἀπὸ γῆς	κ,ηφμβ
Ἀφροδίτης ἀπὸ γῆς	νδ,βψν
Ἡλίου ἀπὸ γῆς	ρξδ
Ἄρεος ἀπὸ γῆς	τϛ,ε
Διὸς ἀπὸ γῆς	βωπδ,ζ
Κρόνου ἀπὸ γῆς	,δχπα,σσν
τῆς ἀπλανοῦς ἀπὸ γῆς, ὃ διπλούμενον ποιεῖ τὴν τῆς σφαίρας διάμετρον	,ϛφλε,ζφ
ἡ δὲ διάμετρος τῆς σφαίρας, δηλονότι πολλαπλασιαζομένη ἡ διάμετρος εἰς γ ζ′ ποιεῖ τὴν τῆς σφαίρας περίμετρον	,ι,γοα,ε ,μ,απα,ηφοα
ὧν τὸ τξ′, ὅπερ ἐστὶ μοῖρα α	ριδ,αρξ⟨β⟩

Commentary

The least distances of the planets from the earth are those computed by al-Farghānī in chapter 21 of his *Differentie* (ed. R. Campani [Città di Castello, 1910], and ed. F. J. Carmody [Berkeley, 1943]; see N. Swerdlow, *Ptolemy's Theory of the Distances and Sizes of the Planets* [unpublished dissertation, Yale University, 1968], 137–41). The only errors are that the distance of the Sun from the earth should be 3,640,000 miles (the number in Campani's edition for the Moon is $109{,}037\frac{1}{2}$ and for the circumference of the sphere of the fixed stars 410,818,570). The computation is based on a value of 3250 miles for the radius of the earth, which approximately corresponds to a circumference of 20,400 miles (see fol. 35.) The distances between the planetary spheres are merely the differences between the given least distances of the planets from the earth. The circumference of the sphere of the fixed stars is correctly computed with the value of π as $3\frac{1}{7}$; the length of a degree in a great circle on the surface of the sphere of the fixed stars is then correctly computed (to the nearest integer) if the restoration of β at the end is right. All of these numbers are also given by al-Farghānī.

Folio 34v

Τὸ μὲν κέντρον τοῦ ἐπικύκλου τῆς Σελήνης καθ' ἑκάστην ἡμέραν ἐπὶ τὰ ἑπόμενα τῶν ζῳδίων μοίρας μεταβαίνει ιγ λεπτὰ γ δεύτερα νδ, τὸ δὲ ἀπόγειον τοῦ ἐκκέντρου μοίρας ια ἐπὶ τὰ ἡγούμενα. ἀφαιρουμένης τοίνυν ἐκ τῆς μέσης κινήσεως τῆς Σελήνης ἤτοι τοῦ κέντρου τοῦ ἐπικύκλου μοίρας μιᾶς διὰ τὸ τὸν Ἥλιον τὴν ἡμέραν μίαν πορεύεσθαι μοῖραν, καὶ προστιθεμένης ταῖς ια τοῦ ἀπογείου τοῦ ἐκκέντρου, συμβαίνει τὸν Ἥλιον μεταξὺ τοῦ κέντρου τοῦ ἐπικύκλου καὶ τοῦ ἀπογείου εὑρίσκεσθαι ἀεὶ ἢ συνοδεύειν τῷ κέντρῳ τοῦ ἐπικύκλου καὶ τῷ ἀπογείῳ ἢ διαμετρεῖν. ὧν οὕτως ἐχόντων, εἰ βούλει τὸ ἀπὸ Κριοῦ ἕως τοῦ ἀπογείου διάστημα εὑρεῖν, λάβε τὴν μέσην κίνησιν Ἡλίου καὶ Σελήνης εἰς τὸν ἐπιζητούμενον χρόνον, καὶ ἀπὸ τῆς κινήσεως τῆς Σελήνης ἄφελε τὴν τοῦ Ἡλίου, καὶ τὴν λειπομένην διπλασίασον· καὶ ἔξεις τὸ ἀπὸ τῆς Σελήνης μέχρι τοῦ ἀπογείου διάστημα. καὶ ἐκ τούτου ἄφελε τὴν μέσην κίνησιν τῆς Σελήνης, καὶ τὸ καταλειπόμενόν ἐστι τὸ ἀπὸ Κριοῦ ἕως τοῦ ἀπογείου διάστημα

Commentary

In general, the author correctly states the relations between the motions of the various elements in the Ptolemaic lunar model. He has, however, erroneously recorded the daily anomalistic motion of the Moon on its epicycle, 13;3,54°, instead of the daily motion of the center of the epicycle on the eccentric, 13;10,35°. And, while the double elongation of the Moon from the Sun is found correctly, the longitude of the lunar apogee is that of the center of the Moon's epicycle diminished by the double elongation. Finally, the daily retrograde motion of the apogee will be the daily elongation diminished by the daily mean motion of the Sun or 11;12,18°, which is equal to the double elongation diminished by the mean motion of the Moon.

Folio 35

I. Τὸ κέντρον τοῦ ἐκκέντρου τοῦ Ἡλίου ἀφέστηκε τοῦ κέντρου τοῦ ζῳδιακοῦ μοίρας β ′ οἵων τὸ ′ τῆς διαμέτρου ξ, τὸ δὲ ἀπόγειον αὐτοῦ ἐν ἀρχῇ τῶν Διδύμων.

II. Τὸ ἀπὸ Ἡλίου μέχρι γῆς διάστημα χίλια διακόσια δέκα ὅσον τὸ ′ τῆς διαμέτρου τῆς γῆς, ἡ δὲ διάμετρος τοῦ Ἡλίου λόγον ἔχει πρὸς τὴν διάμετρον τῆς γῆς ὃν τὰ ια πρὸς τὰ β, τὸ δὲ στερεὸν τοῦ Ἡλίου ρξς δ' ὅσον τὸ στερεὸν τῆς γῆς.

III. Ἡ περίμετρος τῆς γῆς μιλίων ,κυ, ἡ δὲ διάμετρος μιλίων ,συϛ και ια ιδ, ἡ δὲ σκιὰ τῆς γῆς κωνοειδής, ἧς τὸ μῆκος σξζ ὅσον τὸ ′ τῆς διαμέτρου τῆς γῆς.

IV. Τὸ ′ τῆς διαμέτρου τῆς σεληνιακῆς σφαίρας μη τοσαῦτα καὶ να ἑξηκοστὰ ὅσον τὸ ′ τῆς διαμέτρου τῆς γῆς, τὸ δὲ κέντρον τῆς ἐκκέντρου σφαίρας ἀφέστηκε τοῦ κέντρου τῆς γῆς ι τοσαῦτα καὶ θ ἑξηκοστὰ ὅσον τὸ ′ τῆς διαμέτρου τῆς γῆς. τὸ τοίνυν ἐκ τοῦ ἀπογείου τῆς σφαίρας ἄχρι τῆς γῆς νθ τοσαῦτα ὅσον τὸ ′ τῆς διαμέτρου τῆς γῆς, τὸ δὲ ′ τῆς διαμέτρου[a] τοῦ ἐπικύκλου ε τοσαῦτα καὶ ι λεπτά, τὸ δὲ ′ τῆς διαμέτρου τῆς γῆς τριπλάσιον καὶ δισεπίπεμπτον τοῦ ′ τῆς διαμέτρου τῆς Σελήνης.

a After διαμέτρου MS adds, then crosses out, τῆς Σελήνης.

Commentary

I. These parameters are from the *Almagest*; the eccentricity of 2;30 parts and the longitude of the apogee at Gemini 5;30° are both found in III 4.

II. The distance of the Sun from the earth as 1210 terrestrial radii is found in *Almagest* V 15 (see Swerdlow [folio 34, Commentary], 59–70). The ratio of the solar to the terrestrial diameter, $^{11}/_{2}$, is found in *Almagest* V 16 (Swerdlow, 72–73), but the Sun's volume is given there as 170 times the earth's, while in the *Planetary Hypotheses*, Ptolemy states the value as $166\,^{1}/_{3}$ (Swerdlow, 73). Al-Farghānī gives $166\,^{1}/_{4} + {}^{1}/_{8}$ or $(5\,^{1}/_{2})^{3}$ (Swerdlow, 174–75), which must be our author's source.

III. That the circumference of the earth is 20,400 miles is also taken from al-Farghānī, though he uses a diameter of 6,500 miles (folio 34, and Swerdlow, 215–16). However, $20{,}400 \cdot {}^{7}/_{22} = 6{,}490\,^{10}/_{11}$, and $^{10}/_{11} = 0;54,32,43, \ldots$ The text's 6490;21,11,14 implies a value of π close to 3.1433. Ptolemy, in *Almagest* V 15, computes the distance of the vertex of the shadow's cone from the earth as 268 terrestrial radii (Swerdlow, 70–72); I do not know why the Byzantine text has $267\,^{1}/_{2}$.

IV. In *Almagest* V 11–13, Ptolemy computes the mean distance of the Moon to be 48;51 terrestrial radii and the mean distance of the Moon in the syzygies to be 59;0 terrestrial radii (Swerdlow, 41–52). It is also given in *Almagest* V that the Moon's eccentricity is 10;19 parts out of 120 and the radius of its epicycle 5;15 parts; if we multiply these numbers by 0;59, taking the ratio of the radius of the lunar orbit in syzygies to the radius of the deferent, we get 10;8,41 and 5;9,45 terrestrial radii respectively. In the *Planetary Hypotheses*, Ptolemy computes the diameter of the Moon to be $^{1}/_{4} + {}^{1}/_{24}$ terrestrial diameters (Swerdlow, 167–72); this means that the diameter of the earth is about $3\,^{2}/_{5}$ times the diameter of the Moon.

Folio 35v

I. Τὰ ζ κλίματα διῃρημένα κατὰ πλάτος ἀπὸ τοῦ νότου, μᾶλλον δ'ἀπὸ μεσημβρίας ἀρχόμενα ἄχρι τῆς ἄρκτου.

α' τὸ διὰ Μερόης
β' τὸ διὰ Συήνης
γ' τὸ διὰ 'Αλεξανδρείας
δ' τὸ διὰ 'Ρόδου
ε' τὸ δι' 'Ελλησπόντου
ς' τὸ διὰ μέσου Πόντου
ζ' τὸ διὰ Βορυσθένους.

II. 'Ιστέον ὅτι κατὰ τὴν συμπλήρωσιν τῶν ,ατλγ ἐτῶν τοῦ Χριστοῦ τῇ ἐσχάτῃ[a] Δεκεβρίου ποσοῦνται τὰ 'Αράβων ἔτη ψλγ ἡμέραι ριβ λεπτὰ ιδ.

III. 'Ιστέον δ'ὅτι τῇ ιϑ' 'Απριλλίου τοῦ ἔτους ,ατλδ τοῦ Χριστοῦ ὥρας νυκτερινῆς ε' ἐξέλειπεν ἡ Σελήνη τελέως, ἡνίκα ποσοῦνται τὰ 'Αράβων ἔτη ψλγ ἡμέραι σλ λεπτὰ μα ,,.

IV. Ἦν δὲ ἡ τοιαύτη ἔκλειψις κατὰ τὸ ,ϛωμβ' ἔτος τοῦ 'Αδάμ, καϑ' ἣν ὥραν ἐποσοῦντο τὰ ἀπὸ Φιλίππου ἔτη Αἰγύπτια ,αχνη μῆνες ἓξ ἡμέραι κη οὕτως. ἄφελε ,ερπε· λοιπὰ ,αχνζ. αἱ δὲ ἡμέραι ἀπὸ τῆς κϑ' Αὐγούστου ἄχρι τῆς ιϑ' 'Απριλλίου σλδ, καὶ δ' τλϑ · ὁμοῦ φογ. ἄφελε ἔτος α, τξε· λοιπαὶ ἡμέραι ση[b] γίνονται μῆνες ϛ ἡμέραι κη.

a After ἐσχάτῃ MS adds, but crosses out, 'Ιαννουαρίου.
b σι MS.

Commentary

I. These are the standard seven climes used, e.g., in the *Handy Tables*.
II. This computation is based on the rule given on folio 36 (corrected), and is without error. But the true interval is 733 years and 112 days.
III. The lunar eclipse of 19 April 1334 is number 3938 in T. R. von Oppolzer, *Canon der Finsternisse* (Vienna, 1887), and number 403 in J. F. Schroeter, *Spezieller Kanon der Zentralen Sonnen- und Mondfinsternisse* (Kristiania, 1923); it was total, and totality began at about 11 P.M. on Cyprus.

From noon till the fifth hour of the night is $^{11}/_{24} = 0;27,30$ days; and from the end of December till 19 April is 108 days. The true interval in Arabic years, therefore, is 733 years and 220;27,30 days. The rule on folio 36 (corrected) gives 733 years and 220;41,30 days, rather than 733 years and 230;41,30 days.
IV. This computation is based on the rule on folios 26v–27; but, having used the current year of the era of Creation, 6842, rather than the lapsed year, the author corrects his calculation by using the current year of the epoch of the era of Philip, 5185. Also, the interval in days that he gives brings one to the end of 19 April—i.e., noon of 20 April.

Folio 36

διαφοραὶ τῶν ἐτῶν

	ἔτη	ἡμέραι	ἀρχαὶ τῶν ἐτῶν
1. τοῦ Ἀδὰμ εἰς Ἀλέξανδρον	,ερ ϛζ	πϑ	ἀπὸ ἀρχῆς Σεπτεβρίου
2. τοῦ Ἀδὰμ εἰς Χριστόν	,εφη	ρκβ	τοῦ Χριστοῦ ἀπ' ἀρχῆς Ἰαννουαρίου μεσημβρίας
3. τοῦ Ἀλεξάνδρου εἰς Χριστόν	τια	ϛβ	τοῦ Μωάμεϑ ἀόριστα
4. τοῦ Ἀλεξάνδρου εἰς Τζεσδάτζικ	ϡμβ	σνη	
5. τοῦ Ἀλεξάνδρου εἰς Μωάμεϑ	ϡλβ	σπζ	
6. Χριστοῦ εἰς Μωάμεϑ	χκα	ρ ϛε	
7. Χριστοῦ εἰς Τζεσδάτζικ	χλα	ρξς	
8. Μωάμεϑ εἰς Τζεσδάτζικ	ϑ	τλζ	

Commentary

To the eras referred to on folio 26 this table adds the following:

d. Alexander (Seleucid) 1 October – 311
g. Yazdijird (*Zīj al-Shāh*) 16 June 632

Of the relations given here, numbers 2 and 6 correspond to numbers 6 and 11 in the table on folio 26, while numbers 5, 6, and 8 at least occur in the *Toledan Tables* (Toomer, "A Survey of the Toledan Tables" [hereafter, Toomer], 18), though for 6 those tables have 621 Julian years and 185 days, and for 8 they have 9 Julian years and 340 days. The correct intervals, in Julian years and days, are:

1. From a to d. 5197 Julian years and *30* days.
2. From a to e. 5508 Julian years and 122 days.

3. From d to e. 311 Julian years and 92 days.
5. From d to f. 932 Julian years and 287 days.
4. From d to g. 942 Julian years and 258 days.
6. From e to f. 621 Julian years and 195 days.
7. From e to g. 631 Julian years and 166 days.
8. From f to g. 9 Julian years and 337 days.

Folio 36

Περὶ τοῦ εὑρεῖν ἀπὸ τῶν ἐτῶν τοῦ Χριστοῦ τὰ ἔτη τῶν ᾽Αράβων.

Λάβε τὰ ἀπὸ Χριστοῦ ἔτη τὰ τέλεια, ὧν ἄφελε ἔτη χκα, καὶ τὰ λειπόμενα πολλαπλασιάσας εἰς τξε δ′ ποίησον ἡμέρας. καὶ ἐκ τοῦ γινομένου πλήθους τῶν ἡμερῶν ῥίψας ρϛε τὸ καταλειπόμενον πλῆθος ἕως τῆς ἐπιζητουμένης ἡμέρας καὶ ὥρας, αἳ παρ᾽ Αἰγυπτίοις εἰσὶν ἡμέραι · ἃς πολλαπλασίασον πρὸς τὰ λ, καὶ τὸ γενόμενον πλῆθος μέριζε παρὰ τὰ ,αχλα, καὶ ἕξεις τὰ τέλεια ἔτη τῶν ᾽Αράβων. καὶ τὰ καταλειπόμενα κάτωθεν τῶν ,αχλα μέριζε παρὰ τὰ λ, καὶ ἕξεις τὰς ἡμέρας τοῦ ἐνεστῶτος ἔτους τῶν ᾽Αράβων. καὶ τὰς ἡμέρας ποίησον μῆνας, τῷ μὲν ἑνὶ μηνὶ διδοὺς ἡμέρας λ, τῷ δὲ ἑτέρῳ ἡμέρας κϑ · καὶ τὸ περιλειπόμενον πλῆθος αἱ ἡμέραι εἰσὶ τοῦ ἐνεστῶτος μηνός.

Commentary

This procedure is correct, though the reference to the Egyptians remains obscure. The error lies in assuming that an Arabic year contains $\frac{1631}{30} = 54;22$ days, when in fact it has $\frac{10631}{30} = 354;22$ days.

Folio 36^{v}

διόρϑωσις ἐνιαυτῶν ἡλιακῶν καὶ σεληνιακῶν.

This table gives for solar years of $365\frac{1}{4}$ days the corresponding lunar years of $354\ ^{11}/_{30}$ days; the constant difference is 10;53 days. The entries are for 1 to 9, 10 to 90, and 100 to 800 solar years. Below the table is written:

Τὸ ἔτος τὸ ἡλιακὸν ἡμέρας ἔχει τξε δ′, τὸ σεληνιακὸν ἔτος ἔχει ἡμέρας τνδ λεπτὰ κβ, ὥστε τὸ ἔτος τοῦ ῾Ηλίου ἔχει πλέον τοῦ ἔτους τῆς Σελήνης ἡμέρας ι λεπτὰ νγ. ἡ δὲ ἡμέρα λεπτὰ ἔχει ξ, ἡ δὲ ἰσημερινὴ ὥρα λεπτὰ β ′′. ἰστέον δ′ὅτι τὰ ἀπὸ Χριστοῦ ἔτη ἡλιακά εἰσιν, τὰ δὲ τῶν ᾽Αράβων σεληνιακά.

Marginalium. Οὕτως ἔχουσι τὰ ὁμαλὰ ἔτη τοῦ ῾Ηλίου πρὸς τὰ ᾽Αραβικά.[a] ὁμαλὸν δὲ λέγω τὸ ἀπὸ τροπῆς ἐπὶ τροπὴν τὴν αὐτήν, ὅπερ ἔχει ἡμέρας τξε δ′. τὰ δὲ μὴ ὁμαλὰ οὐχ οὕτως, ἀλλὰ τὸ μὲν ἔτος τὸ ἔχον ἡμέρας τξε ὑπερβάλλει τὸ ᾽Αρραβικὸν ἡμέρας ι λεπτὰ λη, τὸ δὲ βίσεξστον ἡμέρας ια λεπτὰ λη, ὡς εἶναι τὴν ὑπεροχὴν τῶν δ ἐτῶν ἡμέρας μγ λεπτὰ λβ.

a After ᾽Αραβικά MS adds, but crosses out, τὰ δὲ α.

Folio 37

᾽Αφαιρουμένων ἀπὸ τῶν τοῦ Χριστοῦ ἐτῶν ἐτῶν χκα καὶ ἡμερῶν ρϛε ὅτε τὰ[a] κατὰ ῞Αραβας ἄρχονται ἔτη, ἐνειστήκει χρόνος τότε ὥρα ϛ′ τῆς ιδ′ ἡμέρας τοῦ ᾽Ιουλίου μηνὸς τοῦ χκβ′ ἔτους ἀπὸ Χριστοῦ, ὅτε αἱ κατὰ ῞Αραβας τῶν πλανήτων ἐλήφθησαν ἐποχαὶ αἱ κάτωθεν ὑποτεταγμέναι.

ἐποχαὶ πλανήτων κατὰ Ἄραβας κατὰ μέσην κίνησιν.

Ἡλίου ζῴδια μοῖρας λεπτά δεύτερα.
Σελήνης μήκους μὲν ζῴδια δ μοῖρας ō λεπτὰ νη.
ἀνωμαλίας δὲ ἤτοι τοῦ ἐπικύκλου ζῴδια ζ μοῖρας κδ ϑ ιε.
Κρόνου μήκους ζῴδια γ μοῖραι κε λεπτὰ να δεύτερα ιε.
Διὸς μήκους ζῴδια ια μοῖραι α λεπτὰ λϑ δεύτερα κζ.
Ἄρεος μήκους ζῴδια ζ μοῖραι α λεπτὰ κδ δεύτερα νϑ.

Τὴν ἀνωμαλίαν τῶν ὑπὲρ τὸν Ἥλιον τριῶν ἀστέρων εὑρήσεις οὕτως. ἀπὸ τῆς μέσης κινήσεως τοῦ Ἡλίου τὴν μέσην κίνησιν τοῦ ἐκκέντρου ἀφελὼν τὸ λοιπὸν ἡ μέση κίνησις τοῦ ἐπικύκλου ἐστίν.

Ἀφροδίτης ἀνωμαλία ζῴδια α μοῖραι ιε λεπτὰ κη δεύτερα λζ.
Ἑρμοῦ ἀνωμαλία ζῴδια β μοῖραι ιγ λεπτὰ μς δεύτερα ιη.

Μίκους κίνησις Ἀφροδίτης καὶ Ἑρμοῦ οὐ λαμβάνεται ἐπειδὴ ἡ αὐτή ἐστι τῷ Ἡλίῳ ἀπαραλλάκτως.

Ἰστέον ὅτι τὰ κανόνια ἀπὸ μεσημβρίας ἄρχονται.

a οἱ corr. to τὰ MS.

Commentary

These epoch longitudes are copied with various omissions and errors from the mean motion tables of the *Toledan Tables*. I give below the values found in the tables on folios 42–67 of the Byzantine version, which agree entirely with those in the Latin (Toomer, 44).

	Toledan Tables	Folio 37
Sun	$3^s\ 23;41,11^0$	
Moon	$4^s\ 0;58,18^0$	$4^s\ 0;58^0$
Moon's anomaly	$3^s\ 18;8,39^0$	$7^s\ 24;9,15^0$
Moon's node	$7^s\ 24;9,55^0$	
Saturn	$3^s\ 25;51,15^0$	$3^s\ 25;51,15^0$
Jupiter	$11^s\ 1;39,37^0$	$11^s\ 1;39,27^0$
Mars	$7^s\ 1;24,59^0$	$7^s\ 1;24,59^0$
Venus' anomaly	$1^s\ 15;28,37^0$	$1^s\ 15;28,37^0$
Mercury's anomaly	$2^s\ 13;46,18^0$	$2^s\ 13;46,18^0$.

The errors on folio 37 may in part come from an Arabic manuscript, in which the figures for 50 and 10 in the seconds of the longitude of the lunar node (mistakenly ascribed to the lunar anomaly) and those for 30 and 20 in the seconds of the longitude of Jupiter could easily have been confused.

Folio 37v

I. Ἰστέον ὅτι ἐν τῷ τέλει τοῦ ,ατλδ' ἔτους ἀπὸ Χριστοῦ, ἤτοι κατὰ τὴν ἐσχάτην τοῦ Δεκεβρίου μηνὸς τὴν συμπληρουμένην ἄχρις ὥρας ς' τῆς ἐσχάτης τοῦ Δεκεβρίου[a] μηνός, ποσοῦνται τὰ ἔτη τῶν Ἀράβων ψλδ καὶ ἡμέραι ρκγ καὶ λεπτὰ ζ, ἀπὸ δὲ τῆς ἀρχῆς τῆς ἑβδόμης ὥρας [τῆς[b]] ἄρχεται τὸ ,ατλε' ἔτος τοῦ Χριστοῦ.

II. ἐποχαὶ τῶν ἀπογείων τῶν ἐκκέντρων σφαιρῶν τῶν πλανήτων κατὰ Ἄραβας.

Ἡλίου ζῴδια β μοῖραι ιζ λεπτὰ ν ἤτοι ἐν Διδύμων μοίρᾳ ιη'.
Σελήνης
Κρόνου ζῴδια η μοῖραι ō λεπτὰ ν ἤτοι ἐν ἀρχῇ τοῦ Τοξότου.
Διὸς ζῴδια ε μοῖραι ιδ λεπτὰ λ ἤτοι ἐν τῇ ιε' μοίρᾳ τῆς Παρθένου.
Ἄρεος ζῴδια δ μοῖραι α λεπτὰ να ἤτοι ἐν τῇ β' μοίρᾳ τοῦ Λέοντος.
Ἀφροδίτης ζῴδια β μοῖραι ιζ λεπτὰ ν ἤτοι ἐν τῇ ιη' μοίρᾳ τῶν Διδύμων.
Ἑρμοῦ ζῴδια ς μοῖραι ιζ λεπτὰ λ ἤτοι ἐν τῇ ιη' μοίρᾳ τοῦ Ζυγοῦ.

a MS wrote first α' τοῦ Ἰαννουαρίου, crossed it out, and wrote above it ἐσχάτης τοῦ Δεκεβρίου.
b After τῆς MS adds, but crosses out, α' Ἰαννουαρίου.

Commentary

I. The author has correctly applied the rules on folio 36; but the actual interval is 734 Arabic years and 123 1/4 days. The time is 6 P.M. of 1 January 1335; the quarter of a day is added because there are 713 Julian years diminished by 195 days between the epoch of the Hijra and the end of 1334, and 713 Julian years contain 260,423 1/4 days. Of course, the year 1335 really began at noon on 1 January 1335, and our astronomer should neither have changed the date to 31 December nor have added the quarter of a day.

II. These longitudes of the apogees are identical with those given in the tables on folios 42–67, and almost identical with those in the Latin *Toledan Tables* (Toomer, 45). The differences are:

	Latin	Byzantine
Saturn	$8^s\ 0;5^0$	$8^s\ 0;50^0$
Mars	$4^s\ 1;50^0$	$4^s\ 1;51^0$

But some Latin manuscripts (e.g., L, S, and Sa) also give the longitude of Mars' apogee as $4^s\ 1;51^0$ (Toomer, 45 note 7).

Folio 38

I. ἐκκεντρότητες τῶν πλανήτων ἤτοι αἱ διαστάσεις μεταξὺ τοῦ κέντρου τοῦ ζῳδιακοῦ καὶ τοῦ κέντρου τοῦ ἐκκέντρου τοῦ φέροντος τὸν ἐπίκυκλον ἧς ὅσας ἔχει μοίρας ἐφ' ἑκάστου πλανήτου οἷων ἡ τοῦ ἐκκέντρου τοῦ αὐτοῦ πλανήτου διάμετρος ρκ.

Ἡλίου μοίρας β ′, οἷων ἡ ἐκ τοῦ κέντρου τοῦ ἐκκέντρου ξ.
Σελήνης
Κρόνου μοῖραι γ λεπτὰ κε.
Διὸς μοῖραι β λεπτὰ με.
Ἄρεος μοῖραι ς ′.
Ἀφροδίτης μοῖραι α δ'.
Ἑρμοῦ μοῖραι ε λεπτὰ κς.

II. Τῇ γ' Μαρτίου ἔτους ,ϛωμε' καὶ τοῦ Χριστοῦ τλζ' ὥρᾳ δ' τῆς ἡμέρας ἐξέλιπεν ὁ Ἥλιος, ἔτη ἀπὸ Φιλίππου ,αχξα μῆνες ε ἡμέραι ιβ.

III. Τῇ ζ' τοῦ Ἰουλίου μηνὸς τοῦ ἔτους ωμζ' καὶ τοῦ Χριστοῦ τλϑ' ὥρᾳ ϑ' τῆς ἡμέρας ἐξέλιπεν ὁ Ἥλιος, ἔτη ἀπὸ Φιλίππου ,αχξγ μῆνες ϑ ἡμέρας ιη.

Commentary

I. These are the eccentricities of the *Almagest* as already given on folios 32v and 35, including the erroneous value 5;26 parts for Mercury's eccentricity and introducing 6;30 in place of the correct 6;0 parts for the eccentricity of Mars. The eccentricity of the Moon is 10;19 parts, which the author on folio 35 has converted into 10;9 terrestrial radii.

II. This solar eclipse is number 6066 in von Oppolzer's *Canon*, number 178 in Schroeter's *Kanon* (see *supra*, p. 104), dated 3 March 1337, with mid-eclipse at about 10 : 30 A.M. on Cyprus; the center of the eclipse passed over Syria, but the eclipse was visible on Cyprus. This date is 1661 Egyptian years 5 months and 12 days after 12 November – 324.

III. This solar eclipse is number 6072 in von Oppolzer's *Canon*, number 179 in Schroeter's *Kanon*, dated 7 July 1339, with mid-eclipse at about 3:30 P.M. on Cyprus; its center passed over western Cyprus. This date is 1663 Egyptian years 9 months and 18 days after 12 November – 324.

Folio 38v

I. πηλικότητες τῶν ἐπικύκλων.

Κρόνου ἡ ἐκ τοῦ κέντρου τοῦ ἐπικύκλου τοιούτων ς ϟ οἵων ἡ ἐκ τοῦ κέντρου τοῦ ἐκκέντρου ξ.
Διὸς ἐκ τοῦ κέντρου τοῦ ἐπικύκλου ἀναλόγως ια ϟ.
Ἄρεος λθ ϟ.
Ἀφροδίτης μγ ς'.
Ἑρμοῦ κβ ϟ.
Σελήνης.

II. ἐποχαὶ πλανήτων ἀπὸ στόματος Ἰωάννου ἀστρολόγου κατὰ διαφόρους χρόνους τοὺς κάτωθεν δηλουμένους τοῦ ἔτους ,ατμ' ἀπὸ Χριστοῦ σαρκώσεως, ἀπὸ Ἀδὰμ δὲ ,ϛωμη'.

τῇ κγ' Ἀπριλλίου ὥρᾳ ς' νυκτερινῇ ἐπιούσης ἡμέρας κδ'.

Ἥλιος	Σελήνη	Κρόνος	Ζεύς	Ἄρης	Ἀφροδίτη	Ἑρμῆς
Ταύρου	Κριοῦ	Τοξότου	Παρθένου	Διδύμων	Ταύρου	Κριοῦ
μοῖρα ια'	α ιε	κγ ιδ	ς ιδ	ιδ ε	κς κα	ιη κε
λεπτὰ μα						

τῇ κζ' τοῦ αὐτοῦ Ἀπριλλίου ὥρᾳ μετὰ μεσημβρίαν δυωδεκάτῃ.

Ἥλιος	Σελήνη	Κρόνος	Ζεύς	Ἄρης	Ἀφροδίτη	Ἑρμῆς
Ταύρου	Ταύρου	Τοξότου	Παρθένου	Διδύμων	Διδύμων	Κριοῦ
ις λβ	ιθ μδ	κγ γ	ς ιβ	ις μα	α λδ	κα νη.

Commentary

I. These values for the radii of the epicycles of the planets are each exactly half the values for their diameters listed on folio 32v and derived from the *Almagest*. The radius of the Moon's epicycle in the *Almagest* is 5;15 parts, which is reduced to 5;10 terrestrial radii on folio 35.

II. These are the true longitudes of the planets as computed by John the Astrologer for midnight of 23/24 April and of 27/28 April of 1340. I have not recomputed these positions with any of the tables available to John, as we know in any case what those tables were, and it seems not worth the effort to determine which he has used in these particular cases. But I do give the planetary positions for these two dates as found in B. Tuckerman, *Planetary, Lunar, and Solar Positions. A.D. 2 to A.D. 1649* (Philadelphia, 1964).

	23/24 April 1340		27/28 April 1340	
	John	Tuckerman	John	Tuckerman
Saturn	263;14	263;45	263;3	263;35
Jupiter	156;14	156;56	156;12	156;54
Mars	74;5	74;35	76;41	77;11
Sun	41;41	41;16	46;32	45;8
Venus	56;21	55;56	61;34	60;50
Mercury	18;25	15;45	21;58	19;22
Moon	1;15	358;30	49;44	47;18

Folios 39–40

Περὶ ψηφηφορίας τῶν ε πλανωμένων.

α′ Πρῶτον μὲν ληπτέον τὸν χρόνον τὸν ἀπὸ τῶν εἰλημμένων ἐποχῶν ἕως τῆς ζητουμένης ὥρας ἀκριβῶς ὡς οἷόν τε. κἂν μὲν σεληνιακὰ ὦσι τὰ ἔτη καθ' ἃ οἱ τῶν κινήσεων κανόνες συντεταγμένοι εἰσὶν ἢ ἄλλως πως ἄνισα τοῖς ἡλιακοῖς, ἰσωτέον αὐτὰ διὰ τῶν κανόνων ἢ διὰ ψήφου, καὶ ποιητέον τὰ ἔτη καὶ τοὺς μῆνας κατὰ τὰ ἐν τοῖς κανόσιν οἷς κέχρησαι
β′ ἔτη. ἔπειτα δὲ τὴν ἐν τοσούτῳ χρόνῳ μέσην κίνησιν ληπτέον ἐκ τῶν τῆς μέσης κινήσεως
γ′ κανόνων μήκους τε καὶ ἀνωμαλίας ἑκατέραν ἰδίᾳ. εἶτα εἰ μὲν μὴ συνειλημμέναι εἶεν ἐν τοῖς κανόσιν αἱ τότε ἐποχαί[a], προσθετέον αὐτὰς[b] ταῖς ληφθείσαις κινήσεσι μήκους τε καὶ ἀνωμαλίας ἑκατέρᾳ ἑκατέραν· εἰ δ' εἶεν συνειλημμέναι τοῖς κανόσιν αἱ ἐποχαί, οὐ προσθετέον
δ′ αὖθις αὐτάς. εἶτα εἰ μὲν αἱ τότε ἐποχαὶ ἀπὸ τῆς ἀρχῆς εἰσι τοῦ Κριοῦ — δηλονότι τοῦ μήκους ἐπεὶ τήν τε τῆς ἀνωμαλίας ἐκ τοῦ ἀπογείου τοῦ ἐπικύκλου ἀνάγκη εἶναι — ἀφαιρετέον ἀπὸ τῆς ληφθείσης τοῦ μήκους κινήσεως τὸ ἀπὸ Κριοῦ μέχρι τοῦ τόπου οὗ νῦν ἐστι τὸ ἀπόγειον διάστημα, καὶ τὰς [f. 39v] καταλειπομένας μοίρας καὶ λεπτὰ φατέον
ε′ εἶναι τὰς ἀπὸ τῶν ἀπογείων ὁμαλὰς ἐποχὰς τῶν μέσων κινήσεων. εἶτα τὸν τοῦ μήκους ἀριθμὸν τὸν ἀπὸ τοῦ ἀπογείου τοῦ ἐκκέντρου εἰσενεγκόντα εἰς τὸν οἰκεῖον τοῦ ἀστέρος κανόνα τῆς ἀνωμαλίας[1] τὰ παρακείμενα τῷ εἰσενεχθέντι τοῦ μήκους ἀριθμῷ ἐν τῷ τρίτῳ σελιδίῳ, οὗ γέγραπται ἡ διόρθωσις τῆς ἐκκεντρότητος. εἰ μὲν ὁ εἰσενεχθεὶς τοῦ μήκους ἀριθμὸς ἐλάττων ἢ τῶν ρπ, ἀφελοῦμεν μὲν τῶν τοῦ μήκους μοιρῶν, προσθήσομεν δὲ ταῖς τῆς ἀνωμαλίας· εἰ δὲ μείζων τῶν ρπ, προσθήσομεν μὲν ταῖς τοῦ μήκους, ἀφελοῦμεν δὲ τῶν
ς′ τῆς ἀνωμαλίας ἵνα ἔχωμεν ἀμφοτέρας τὰς παρόδους διευκρινημένας. ἔπειτα τὸν μὲν ἀπὸ τοῦ ἀπογείου τῆς ἀνωμαλίας[2] διευκρινημένον ἀριθμὸν εἰσενεγκόντες εἰς τὰ πρῶτα δύο σελίδια τὴν παρακειμένην αὐτῷ κατὰ τὸ ἕκτον σελίδιον τῆς μέσης ἀποστάσεως προσθαφαίρεσιν ἀπογραψόμεθα, τὸν δὲ ἐξ ἀρχῆς προεισενηνεγμένον τοῦ ὁμαλοῦ μήκους ὁμοίως εἰσενεγκόντες εἰς τοὺς αὐτοὺς ἀριθμούς. ἐὰν μὲν ἐν τοῖς πρώτοις καὶ ἀπογειοτέροις ᾖ στίχοις τοῦ κατὰ τὴν μέσην ἀπόστασιν, ἅπερ ἐκ τῶν ἐν τῷ τετάρτῳ[c3] σελιδίῳ ἑξηκοστῶν, ἃ καὶ ἀναλογικὰ προσαγορεύουσι λεπτά, γίνεται — δῆλον τὰ παρακείμενα αὐτῷ ἑξηκοστὰ ἐν αὐτῷ τῷ τετάρτῳ σελιδίῳ — ὅσα ἂν ᾖ, τὰ τοσαῦτα λαβόντες τοῦ παρακει [f. 40] μένου διαφόρου τῷ στίχῳ τῆς ἀπογεγραμμένης μέσης προσθαφαιρέσεως ἐν τῷ τῆς μεγίστης ἀποστάσεως σελιδίῳ, τὰ γενόμενα ἀφελοῦμεν ὧν ἀπεγραψάμεθα. ἐὰν δ' ὁ τοῦ εἰρημένου

μήκους ἀριθμὸς ἐν τοῖς ὑποκάτω καὶ περιγειοτέροις ἢ στίχοις τοῦ κατὰ τὴν μέσην ἀπόστασιν, τὰ παρακείμενα αὐτῷ ὁμοίως ἐξηκοστὰ ἐν τῷ τετάρτῳ σελιδίῳ τῶν ἀναλογικῶν λεπτῶν, ὅσα ἂν ᾖ, τὰ τοσαῦτα λαβόντες τοῦ παρακειμένου διαφόρου τῇ ἀπογεγραμμένῃ
ζ′ μέσῃ προσθαφαιρέσει ἐν τῷ τῆς ἐλαχίστης ἀποστάσεως σελιδίῳ, τὰ γενόμενα προσθήσομεν οἷς ἀπεγραψάμεθα. καὶ τὰς συναχθείσας μοίρας τῆς διακεκριμένης προσθαφαιρέσεως, ἐὰν μὲν ὁ διευκρινημένος τῆς ἀνωμαλίας ἀριθμὸς ἐλάττων ἢ τῶν ρπ μοιρῶν, προσθήσομεν ταῖς τοῦ διευκρινημένου μήκους μοίραις, ἐὰν δὲ[d] μείζων ἢ τῶν ρπ, ἀφελοῦμεν αὐτὰς τῶν τοῦ μήκους, καὶ τὸν συναχθέντα τῶν μοιρῶν ἀριθμὸν ἐκβαλόντες ἀπὸ τοῦ ἀπογείου τοῦ
η′ ἐκκέντρου ἐπὶ τὴν φαινομένην αὐτοῦ πάροδον καταντήσομεν. οἷς προσθέντες αὖ τὸ ἀπὸ Κριοῦ μέχρι τοῦ ἀπογείου διάστημα ἕξομεν τὸ ἀπὸ Κριοῦ ἄχρι τῆς φαινομένης πάροδον.

Marginalia

1. οὐ τὸν ἐπίκυκλον ἐνταῦθά φησιν ἀνωμαλίαν, ἀλλὰ τὴν ἀνώμαλον κίνησιν.
2. τουτέστι τοῦ ἐπικύκλου.
3. ταῦτα τὰ ἑξηκοστὰ Πτολεμαῖος ἐν τῷ η′ σελιδίῳ τάττει.

a MS wrote αἱ ἀφ' οὗ ἄρχονται τότε ὁ ληφθεὶς χρόνος ἐποχαὶ ἐν τοῖς κανόσιν οὐκ εἰσί, crossed it out, and wrote above it μὴ — ἐποχαί.
b After αὐτὰς MS adds, but crosses out, τότε ἐποχαὶ.
c MS wrote ἕκτῳ, crossed it out, and wrote τετάρτῳ above.
d After δὲ MS adds, but crosses out, κα.

Folio 40v

Περὶ τῆς ψηφηφορίας τοῦ Ἡλίου

Συναγαγόντες ἐκ τῶν τῆς μέσης κινήσεως κανόνων τὴν τοῦ Ἡλίου μέσην κίνησιν — δηλονότι τοῦ μήκους· οὐ γὰρ λαμβάνεται ἐπὶ τοῦ Ἡλίου ἐπίκυκλος — τὸν συναχθέντα τῶν μοιρῶν ἀριθμόν (μεθ' ὅλους κύκλους ὁμαλὰς ἐποχὰς εἰς τὸν ἐπιζητούμενον χρόνον ἀπὸ τοῦ ἀπογείου[a]) εἰσενεγκόντα εἰς τὸν κανόνα τῆς διορθώσεως, τὰ παρακείμενα τῷ αὐτῷ ἀριθμῷ τῆς μέσης κινήσεως κατὰ τὸ τρίτον σελίδιον τὸ ἐπιγεγραμμένον διόρθωσιν τοῦ ἐκκέντρου. εἰ μὲν ὁ τῆς μέσης κινήσεως ἀριθμὸς ἐλάττων ἢ τῶν ρπ, ἀφαιρετέον ἀπὸ τῆς μέσης κινήσεως, εἰ δὲ μείζων, προσθετέον αὐτὰ τῇ μέσῃ κινήσει. καὶ τὰς γενομένας μοίρας εἶναι φατέον τὴν ἀπὸ τοῦ ἀπογείου φαινομένην πάροδον τοῦ Ἡλίου. ᾧ προσθετέον τὸ ἀπὸ Κριοῦ μέχρι τοῦ ἀπογείου, καὶ ἕξομεν τὸ ἀπὸ Κριοῦ ἕως τοῦ Ἡλίου διάστημα.

a ἀπὸ τοῦ ἀπογείου written by MS above εἰσενεγκόντα.

Folios 41–41v

Περὶ ψηφηφορίας Σελήνης ἐν τοῖς κανονίοις τῆς Τολέτας.

Εἰ βούλει τὴν ἀκριβῆ τῆς Σελήνης ἐποχὴν εὑρεῖν, συναγαγὼν ἐκ τῶν τῆς μέσης κινήσεως χρόνων τὴν μεθ' ὅλους κύκλους ὁμαλὴν ἐποχὴν εἰς τὸν ἐπιζητούμενον χρόνον μήκους τε καὶ ἀνωμαλίας[a], ὁμοίως δὲ καὶ τὴν τοῦ Ἡλίου μέσην κίνησιν εἰς τὸν αὐτὸν χρόνον, ἄφελε τὴν τοῦ Ἡλίου κίνησιν ἀπὸ τοῦ μήκους τῆς Σελήνης. καὶ τὸ καταλειπόμενον διπλασιάσας ἕξεις τὸ ἀπὸ τοῦ ἀπογείου μέχρι τῆς Σελήνης διάστημα, ὃ εἰσενεγκὼν εἰς τὸν τῆς ἀνωμαλίας κανόνα[b], τὰ παρακείμενα τῷ τοιούτῳ ἀριθμῷ ἐν τῷ τρίτῳ σελιδίῳ τῷ ἐπιγεγραμμένῳ διορθώσει τοῦ ἐκκέντρου· καὶ ἔτι τὰ ἐν τῷ τετάρτῳ, ὃ ἐπιγράφεται λεπτὰ ἀναλογικά, ἀπογραπτέον ἕκαστον ἰδίᾳ. εἶτα εἰ μὲν ὁ εἰσενηνεγμένος τοῦ ὁμαλοῦ μήκους ἀριθμὸς ἐλάττων ἐστὶ μοιρῶν ρπ, τὰ παρακείμενα αὐτῷ ἐν τῷ τρίτῳ σελιδίῳ προσθήσομεν ταῖς τῆς ἀνωμαλίας μοίραις, εἰ δὲ μείζων τῶν ρπ, ἀφελοῦμεν ταῦτα τῆς ἀνωμαλίας.[1] ἔπειτα τὸν οὕτω διακεκριμένον τῆς ἀνωμαλίας ἀριθμὸν εἰσενεγκόντες εἰς τὰ πρῶτα δύο σελίδια, τὰ παρακείμενα αὐτοῖς ἐν τῷ ς′ τῷ ἐπιγεγραμμένῳ διορθώσει τοῦ ἐπικύκλου. καὶ ἔτι ἐν τῷ πέμπτῳ τῷ ἐπιγράφοντι

διαφορᾷ διαμέτρου ἀπογραψόμεθα ἕκαστον ἰδίᾳ, καὶ πολλαπλασιάσαντες τὰ ἐν τῷ δ' ἀναλογικὰ λεπτὰ πρὸς τὰ ἐν τῷ ε', ἤτοι τὴν διαφορὰν τῆς διαμέτρου, τὰ γινόμενα προσθήσομεν τοῖς τοῦ ἕκτου, ἤτοι τῇ λεγομένῃ διορθώσει τοῦ ἐπικύκλου. εἶτα τὴν οὕτω διακεκριμένην τοῦ ἐπικύκλου διόρθωσιν, εἰ μὲν ὁ διακεκριμένος τῆς ἀνωμαλίας ἀριθμὸς ἐλάττων ᾖ τῶν ρπ, ἀφαιρετέον ἀπὸ τῶν τοῦ μήκους μοιρῶν, εἰ δὲ πλείων τῶν ρπ, προσθετέον ταῖς τοῦ μήκους μοίραις καὶ οὕτως ἕξομεν καὶ τὰς τοῦ μήκους μοίρας διακεκριμένας[c]. ἀπὸ τούτων οὖν τῶν διακεκριμένων τοῦ μήκους μοιρῶν[2] ἀφαιρετέον ἀεὶ τὸ ἀπὸ τοῦ ἀπογείου μέχρι τοῦ Κριοῦ ὡς πρὸς τὰ ἑπόμενα διάστημα, προσλαμβάνοντες ταῖς τοῦ μήκους μοίραις κύκλου μοίρας τξ (ἂν μὴ πλεῖον ᾖ τὸ μῆκος) ὥστε ἐξ αὐτοῦ ἀφαιρεῖν τὸ ἀπόγειον. καὶ τὰς καταλειπομένας μοίρας ἐκβαλόντες ἀπὸ Κριοῦ εἰς τὰ ἑπόμενα, οὗ ἂν καταντήσῃ ὁ τῶν μοιρῶν ἀριθμός, ἐκεῖ τὴν ἀκριβῆ τῆς Σελήνης εἶναι φήσομεν πάροδον. εἰ δὲ μὴ ταύτῃ γέγονεν ἡ προσθαφαίρεσις, ἀλλὰ τῇ ἐξ ἀρχῆς ληφθείσῃ μέσῃ κινήσει, οὐ δεῖ τὸ ἀπὸ τοῦ ἀπογείου ἄχρι τοῦ Κριοῦ ἀφαιρεῖν· ἡ γὰρ οὕτως ληφθεῖσα κίνησις ἀπὸ Κριοῦ ἄρχεται ἧς γενομένης τῆς προσθαφαιρέσεως ἡ ἀκριβὴς εὐθὺς καταλαμβάνεται.

Marginalia

1. ⟨ἀν⟩ωμαλίαν ⟨τὴ⟩ν ἐπίκυ⟨κλ⟩όν φησι.
2. εἰ γέγονεν ἡ προσθαφαίρεσις ἐπὶ τῆς κινήσεως τῆς ἀπὸ τοῦ ἀπογείου τῆς εἰσενηνεγμένης δηλαδὴ εἰς τὸν κανόνα τῆς διορθώσεως.

a μήκους — ἀνωμαλίας written by MS above χρόνον — καὶ.
b. After κανόνα MS adds, but crosses out, εἰ μὲν.
c. After διακεκριμένας MS adds, but crosses out, καὶ εἰ μὲν εὑρεθῇ κατ' ἐκεῖνον τὸν χρόνον τὸ ἀπόγειον τῆς Σελήνης μεταξὺ τοῦ Κριοῦ καὶ τῆς Σελήνης εἰς τὰ ἑπόμενα τῶν ζῳδίων, προσθετέον ταῖς οὕτω διακεκριμέναις τοῦ μήκους μοίραις τὸ ἀπὸ ἀρχῆς τοῦ Κριοῦ μέχρι τοῦ ἀπογείου, εἰ δὲ μεταξὺ τοῦ ἀπογείου καὶ τῆς Σελήνης εὑρίσκοιτο ὁ Κριός, ἀφαιρετέον τῶν διακεκριμένων τοῦ μήκους μοιρῶν τὸ ἀπὸ τοῦ ἀπογείου μέχρι τοῦ Κριοῦ. καὶ τὰς καταλειπομένας μοίρας ἐκβαλόντες ἀπὸ Κριοῦ εἰς τὰ ἑπόμενα, ἑκάστῳ ζῳδίῳ δόντες μοίρας λ, ὅπου δ'ἂν καταντήσῃ ὁ ἀριθμός, ἐν ἐκείνῳ τῷ ζῳδίῳ καὶ τῇ μοίρᾳ φαμὲν κινεῖσθαι τηνικαῦτα τὴν Σελήνην.

Commentary

Despite the errors in grammar and spelling, these three chapters on folios 39–41^{v} give clear rules for computing planetary longitudes from the *Toledan Tables* on folios 42–70^{v}.

The next 63 folios contain the Greek version of the *Toledan Tables*, for which in describing (with a few exceptions) I shall give only the titles, a reference to Toomer's description of the Latin version, and the marginalia due to the original scribe of the manuscript, whom I assume to be George Lapithes. The Greek version contains the following tables in Toomer's arrangement:

1. ff. 97 and 99^{v}
2. f. 99^{v}
3. f. 97
4. f. 97^{v}
5. f. 97^{v}
6. ff. 98 and 98^{v}
9. ff. 98 and 98^{v}
10. f. 99^{v}
32. ff. 51–51^{v} and 99
33. ff. 55–55^{v}
34. ff. 59–59^{v}
35. ff. 63–63^{v}
36. ff. 67–67^{v} and 99
37. ff. 43–43^{v}
38. f. 90^{v}
39(1–5). ff. 46–48^{v}
54. f. 79
55. f. 79^{v}
56. f. 80
58. f. 82^{v}
59. f. 82
60. ff. 84–84^{v}
61. f. 83^{v}
63. f. 80^{v}

11. f. 98v
12. ff. 89v–90
13. ff. 88v–89
14. f. 89
15. f. 90v
16. f. 90v
17. ff. 91–91v
18. ff. 92–92v
19. ff. 93–93v
28. ff. 42–42v and 104
29. ff. 44–44v and 104
30. ff. 45–45v and 104v
31. f. 50
39(6). ff. 49–49v
40(1–6). ff. 52–54v
41(1–6). ff. 56–58v
42(1–6). ff. 60–62v
43(1–6). ff. 64–66v
44(1–6). ff. 68–70v
40–44(7). ff. 71–73v
45. ff. 74–76v
46. ff. 77–78
49. f. 87v
51. f. 81v
52. f. 78v
53. f. 78v
66. f. 81
67. f. 81v
76. ff. 79v
77. f. 79v and 81v
78. f. 79v
79. f. 80
80. f. 83
81. f. 88
82. f. 84v
83. f. 85
84. ff. 94–96v
85. ff. 85v–87

The arrangement in the Byzantine version seems to be a variant of that found in Toomer's Latin manuscript V (Vindobonensis 2385) of the thirteenth century (Toomer, 7).

V	Byz
ff. 1–2 (1–6,9)	ff. 97–98 (1,3–6,9) and 99v (1–2)
ff. 3–4 (12)	ff. 89v–90 (12)
f. 4v (16,15,38)	f. 90v (16,15,38)
ff. 5–7v (17–19)	ff. 91–93v (17–19)
ff. 8–10v (84)	ff. 94–96v (84)
ff. 11–27 (28,37,29,30,39,31,32,40, 33,41,34,42,35,43,36,44)	ff. 42–70v (28,37,29,30,39,31,32,40,33,41, 34,42,35,43,36,44)
ff. 27v–29v (45–46)	ff. 74–78 (45–46)
ff. 30–30v (52–55)	ff. 78v–79 (52–55)
f. 32 (56,79,77,78,76,57)	ff. 79v–80 (78,76,77,56,79)
ff. 32v–33v (66,63,67)	ff. 80v–81v (63,66,67)
ff. 33v–34 (59,58)	ff. 82–82v (59,58)
f. 34v (80)	f. 83 (80)
f. 34v–35v (61,60)	ff. 83v–84v (61,60)
f. 36 (82)	f. 84v (82)
f. 36v (83)	f. 85 (83)
ff. 37–38v (85)	ff. 85v–87 (85)
f. 39 (49–50)	f. 87v (49)
f. 39v (51)	f. 81v (51)
f. 39v (81)	f. 88 (81)
f. 40 (11,10)	f. 98v (11) f. 99v (10)
ff. 40v–41 (13–14)	ff. 88v–89 (13–14)

The close relationship of the Byzantine version to that of V is also confirmed by the headings of some tables.

Folios 42–42v

Κανόνες τῆς τοῦ Ἡλίου μέσης κινήσεως τοῦ μήκους. ἄρχονται οἱ κανόνες οὗτοι ἀπὸ τοῦ Μωάμεθ μηνὶ Ἰουλίῳ ιδ' ὥρᾳ μεσημβρίας τοῦ ἔτους ἀπὸ Χριστοῦ χκβ', λαμβάνεται δὲ πρώτη ἡμέρα ἡ ιε' Ἰουλίου πληρουμένη τῇ ιε' μεσημβρίας.

This is Toomer, table 28. It and tables 32–36 have each nine sections (see Toomer, 44–55).

I. μέση κίνησις (Ἡλίου) ἐν ἔτεσιν Ἀραβικοῖς συνθέτοις ἐν τῷ μεσημβρινῷ τῆς Τολέτας. This gives the epoch positions (see folio 37) and mean longitudes for every 30 Arab years beginning with A.H. 450 (began 28 February 1058) and extending to about A.H. 840/900 (for the Sun to A.H. 900).

II. μέση κίνησις (Ἡλίου) ἐν ἔτεσιν Ἀράβων ἁπλοῖς. This gives the mean motions for 1 to 30 Arab years.

III. τὸ ἀπόγειον (τοῦ Ἡλίου). This gives the longitudes of the apogees (see folio 37v).

IV. μέση κίνησις (Ἡλίου) ἐν ἡμέρᾳ μιᾷ. These are the mean daily motions of Ptolemy (see Toomer, 44, and marginalium 3 below).

V. μέση κίνησις (Ἡλίου) ἐν μησὶ σεληνιακοῖς. These are the mean motions in each Arab month; the months are not named as in the Latin version (Toomer, 47) but are numbered 1 to 12.

VI. μέση κίνησις (Ἡλίου) ἐν ἡμέραις σεληνιακοῖς.

VII. μέση κίνησις (Ἡλίου) ἐν ὥραις ἰσημεριναῖς.

VIII. λεπτὰ ὡρῶν. These tables not in Toomer; they give fractions of the hourly mean motions of the planets. The table for the Sun, whose hourly motion is $0;2,28^0$, is, in modern notation:

$\frac{1}{2}$	$0;1,14,0^0$
$\frac{1}{3}$	$0;0,48,0^0$
$\frac{1}{5}$	$0;0,28,8^0$
$\frac{1}{6}$	$0;0,24,4^0$

IX. μέση κίνησις (Ἡλίου) ἐν ἑξηκοσταῖς ὥραις. For the Sun, this is for 0;2, 0;4, 0;6, . . . 1;0 hours.

Marginalia on f. 42

1. Το I. Ἰστέον ὅτι διὰ τὸ συγκεῖσθαι τὰς ἀπὸ Κριοῦ ἐποχὰς ἐν τοῖς κανόσι τούτοις ταῖς μέσαις κινήσεσι δεῖ λαβόντα τὰς μέσας κινήσεις μήκους τε καὶ ἀνωμαλίας ἀφαιρεῖν τὸ ἀπὸ Κριοῦ ἕως τοῦ ἀπογείου τοῦ ἐκκέντρου, καὶ τὰς λοιπὰς μοίρας καὶ λεπτὰ εἰσάγειν εἰς τὸν κανόνα τῆς διορθώσεως, καὶ δὶς αὐτὸν διευκρινήσαντα κατὰ τὴν παραδεδομένην μέθοδον αὖθις προστιθέναι αὐτῇ τὸ ἀπόγειον καὶ τὴν τοῦ ἀπογείου κίνησιν. καὶ οὕτως ἕξομεν τὰς ἀκριβεῖς ἐποχὰς τῶν ἀστέρων. Cf. folios 39–40v.

2. Το I. Ἰστέον ὅτι οἱ κανόνες οὗτοι οὐκ ἀπὸ τοῦ ἰσημερινοῦ ποιοῦνται τὴν ἀρχὴν τοῦ Κριοῦ, ἀλλὰ κατὰ τὴν ὀγδόην σφαῖραν ἤτοι μετὰ μοίρας θ τοῦ ἰσημερινοῦ. διὸ μετὰ τὴν ψηφηφορίαν τῶν ἐνταῦθα κανόνων δεῖ προστιθέναι μοίρας θ ἵνα εὕρομεν τὴν ἐποχὴν τὴν ἀπὸ Κριοῦ τῆς θ' σφαίρας. Cf. folio 88.

3. Το IV. Ἰστέον ὅτι τὰ ἐπιγεγραμμένα ἐν τοῖς κανόσι τούτοις ἡμερήσια κινήματα τοῦ Ἡλίου καὶ Κρόνου καὶ Διὸς καὶ Ἄρεος συμφωνεῖ τοῖς ἐν τῇ Συντάξει, τὰ δὲ τῶν ἐπικύκλων Ἀφροδίτης καὶ Ἑρμοῦ ἔχουσι ταῦτα πλέον τῶν τῆς Συντάξεως ἐν ἡμέραις τριάκοντα, τῆς μὲν Ἀφροδίτης λεπτὰ δεύτερα δ, τοῦ δὲ Ἑρμοῦ λεπτὰ δεύτερα β. Cf. *Almagest* IX 4, where the anomalistic motions of Venus and Mercury for 30 days are respectively $0;0,4^0$ and $0;0,2^0$ less than those in the *Toledan Tables*.

Marginalium on f. 42v

1. διάστασις λεπτὰ γ δεύτερα ιζ τρίτα κ.

Folios 43–43v. Διόρθωσις τῆς τοῦ Ἡλίου κινήσεως.

This is table 37 Toomer. It and tables 39–44 are arranged as in the *Toledan Tables* (pp. 56–68), save that column 6 of table 39 is given as a separate table on folios 49–49v, and the columns 7 of tables 40–44 are consolidated into a separate table on folios 71–73v.

Marginalium on f. 43

1. Ἡ διόρθωσις αὕτη τοῦ ἐκκέντρου τοῦ Ἡλίου ἄνισός ἐστι τῇ ἐν τοῖς Προχείροις διορθώσει· ἐκεῖ γὰρ ἡ μεγίστη ἐστὶ μοίρας β κγ, ἐνταῦθα δὲ ὡς ὁρᾷς μοιρῶν α νϑ, ὡς εἶναι διαφορὰν λεπτὰ κδ τῆς μεγίστης.

Folios 44–44v. Μέση κίνησις Σελήνης ἤτοι τοῦ κέντρου τοῦ ἐπικύκλου.

This is table 29 Toomer.
I (to A.H. 870), II, IV, V, VI, VII, VIII, IX (0;2–1).
VIII in our notation:

$^1/_2$ 0;16,28,8^0
$^1/_3$ 0;10,18,45^0
$^1/_5$ 0;6,35,15^0
$^1/_6$ 0;5,29,22^0

Marginalia on f. 44

1. Το I. Ἡ ἐποχὴ ἀπὸ Κριοῦ ἐστιν, οὐκ ἀπὸ τοῦ ἀπογείου.
2. Το I. Πεντεκαιδεκάκις τὰ λ ποιεῖ κίνησιν ἐτῶν υν· ζῳδια ς κζ λβ με.
Since the mean motion in 30 years is 37;50,11^0, it amounts in 450 years to 3,27;32,45^0.
3. Το II. Ἰστέον ὅτι τὰ ἁπλᾶ ἔτη οὐκ ἐπὶ ὁμαλὴν αὔξησιν κεῖνται, ἀλλ' ἐκ διαστημάτων αὔξεται ἡμερήσιον κίνημα ἐν τοῖς ἔτεσι τούτοις· β′, ε′, ζ′, ι′, ιγ′, ις′, ιη′, κα′, κδ′, κς′, κϑ′ διὰ τὰ κβ λεπτὰ ἅπερ ἔχει ἕκαστον ἔτος, ἅπερ γίνεται ἐν τριάκοντα ἔτεσιν ἡμέραι ια. The eleven years noted are the leap years according to the *Toledan Tables* (Toomer, 15).

Marginalia on f. 44v

1. Το (III). Οὐ κεῖται ἐνταῦθα κίνησις τοῦ ἀπογείου τῆς Σελήνης διὰ κεῖσθαι τὴν κίνησιν τοῦ κέντρου τοῦ ἐπικύκλου ἀφαιρουμένης τῆς τοῦ ἀπογείου κινήσεως. ὅταν δὲ βουλώμεθα τὴν τῆς Σελήνης ἀπὸ τοῦ ἀπογείου διάστασιν λαβεῖν ἵνα εἰς τοὺς τῆς διορθώσεως κανόνας αὐτὴν εἰσαγάγωμεν, ἀφαιροῦμεν τὴν μέσην κίνησιν τοῦ Ἡλίου ἀπὸ τῆς μέσης κινήσεως τῆς Σελήνης, καὶ τὸ καταλειπόμενόν ἐστιν ἡ διάστασις Ἡλίου καὶ Σελήνης· ἣν διπλασιάσαντες ἕξομεν τὸ τῆς Σελήνης ἀπὸ τοῦ ἀπογείου διάστημα, ὃ εἰσάγοντες εἰς τοὺς κανόνας τῆς διορθώσεως ποιούμεθα τὴν διόρθωσιν. Cf. folios 41–41v.
2. Το IV. Ἀπὸ τῆς ἡμερησίου κινήσεως Σελήνης ἀφαιρουμένης ἡμερησίου κινήσεως τοῦ Ἡλίου λείπεται ἡμερήσιος κίνησις μοῖραι ιβ ια κζ. συμβαίνει οὖν ἐν ἡμέραις κϑ ͵ καὶ λεπτὰ ὥρας μβ κινεῖσθαι μοίρας τξ καὶ λεπτὰ δεύτερα ζ. τοσοῦτος ἄρα χρόνος ἀπὸ συνόδου εἰς σύνοδον τῆς μέσης κινήσεως. The length of a mean synodic month is 6,0^0: 12;11,27$^{0/d}$ = 29;31,49,23, . . .^{d}; I do not understand the text's computation.

Folios 45–45v. Κίνησις ἀνωμαλίας Σελήνης ἤτοι τοῦ ἐπικύκλου μέση κίνησις.

This is table 30 Toomer.
I (to A.H. 840), II, IV, V, VI, VII, VIII, IX (0;1–0;30 = 0;2–1).
VIII in our notation:

$^1/_2$ 0;16,20,0^0
$^1/_3$ 0;10,53,20^0
$^1/_4$ 0;6,35,15^0
$^1/_5$ 0;5,29,22^0

Marginalia on f. 45

1. To I. Ἡ ἐποχὴ αὕτη ὀρθή ἐστιν.
2. To I. Τὰς τριακονταετηρίδας πεντεκαιδεκάκις ποιήσαντες ἕξομεν κίνησιν ἐτῶν υν τῆς ἀνωμαλίας Σελήνης ζῳδια β κδ ϑ ιε. Since the mean motion in 30 years is 4,53;49,58^0, in 450 years it is 1,27;29,30^0; the text is in error.
3. To VI. Ἡ κίνησις αὕτη τοῦ κέντρου τῆς Σελήνης περὶ τὸν οἰκεῖον ἐπίκυκλον ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κινήσει ἐν ταῖς ἡμέραις· τὰ γὰρ ἕ⟨τη⟩ ἄνισά ἐστιν ἀλλήλοις.

Marginalium on f. 45^v

1. To IX. Δεῖ εἰδέναι ὅτι ἔνθα οὐχ εὑρίσκονται τὰ λεπτὰ τῶν ὡρῶν ξ ἀλλὰ λ ὡς ἐνταῦθα ἥμισυ ὥρας εἰσὶ ταῦτα, ἀλλ' οὐ διπλᾶ εἰσιν ὥστε εἶναι τὰ λ ἀντὶ ξ.

Folios 46–48^v. Κανόνες Σελήνης ἤτοι διόρθωσις τοῦ μήκους.

This is table 39 Toomer without column 6, which is on folios 49–49^v.

Marginalium on f. 46

1. Ἡ διόρθωσις αὕτη Σελήνης ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις.

Folios 49–49^v. Κανόνες τῆς κατὰ πλάτος διορθώσεως τῆς Σελήνης.

This is column 6 of table 39 Toomer.

Marginalium on f. 49

1. Ἰστέον ὅτι τὸ πλάτος τοῦτό ἐστιν ἡ λόξωσις τοῦ κύκλου τῆς Σελήνης πρὸς τὸν ἐκλειπτικὸν ἤτοι τὸν διὰ μέσων τῶν ζῳδίων· ἄρχονται δὲ οἱ ἀριθμοὶ ἀπὸ τοῦ Ἀναβιβάζοντος.

Folios 50–50^v. Κίνησις τῆς κεφαλῆς τοῦ δράκοντος ἀρχομένη ἀπὸ Κριοῦ πρὸς τὰ ἡγούμενα.

This is table 31 Toomer.
I (to A.H. 870), II, V, VI, VII, VIII, IX (0;2–1).
VIII in our notation:

$^1/_2$ 0;0,3,59^0
$^1/_3$ 0;0,2,40^0
$^1/_5$ 0;0,1,36^0
$^1/_6$ 0;0,1,20^0

Marginalium on f. 50

1. Δράκοντος κεφαλὴν καλοῦσιν οἱ Ἄραβες τὸν ἀναβιβάζοντα σύνδεσμον, οὐρὰν δὲ τὸν καταβιβάζοντα· κίνησιν δὲ ἔχει τὴν τοῦ βορείου πέρατος.

Folios 51–51^{v}. Κανόνες τῆς τοῦ Κρόνου μέσης κινήσεως.

This is table 32 Toomer.
I (to A.H. 840), II, III, IV, V, VI, VII, VIII, IX (0;1–0;30).
VIII in our notation:

$^{1}/_{2}$ 0;0,2,31^{0}
$^{1}/_{3}$ 0;0,1,40^{0}
$^{1}/_{5}$ 0;0,1,0^{0}
$^{1}/_{6}$ 0;0,0,50^{0}

Marginalia on f. 51

1. To I. Ἡ ἐποχὴ αὕτη καὶ Διὸς καὶ Ἄρεος ἀπὸ τῆς ἀρχῆς τοῦ Κριοῦ ἐστι τοῦ κατὰ τὴν ὀγδόην σφαῖραν, ἥτις διέστηκε τῆς ἀρχῆς τοῦ Κριοῦ κατὰ τὴν ἑνάτην σφαῖραν, ὅπερ ἄρχεται ἀπὸ τοῦ ἰσημερινοῦ μοίρας λεπτά
2. Ἡ κίνησις αὕτη οὐ περιέχει τὴν κίνησιν τοῦ ἀπογείου, ἀλλὰ δεῖ αὐτὴν ὕστερον προστιθέναι.
3. Ἡ μέση κίνησις τῆς ἀνωμαλίας ἤτοι τοῦ κέντρου τοῦ ἀστέρος ἀφείθη ἐπὶ τῶν γ ἀστέρων Κρόνου, Διός, καὶ Ἄρεος διότι, ἀπὸ τῆς τοῦ Ἡλίου μέσης κινήσεως ἀφαιρουμένης τῆς μέσης κινήσεως τοῦ κέντρου τοῦ ἐπικύκλου ἑκάστου τῶν εἰρημένων ἀστέρων, τὸ καταλειπόμενόν ἐστιν ἡ κίνησις τοῦ κέντρου τοῦ ἀστέρος αὐτοῦ, ἣν εἰσάγομεν εἰς τὰς διορθώσεις ἀφαιροῦντες τὸ ἀπόγειον.

Folios 52–54^{v}. Διόρθωσις Κρόνου μέσης κινήσεως καὶ ἀνωμαλίας.

This is table 40 Toomer without column 7.

Marginalium on f. 53

1. Ἡ διόρθωσις αὕτη ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κανόσιν.

Folios 55–55^{v}. Διὸς μέση κίνησις τοῦ μήκους κατὰ τὴν ὀγδόην σφαῖραν· οὐ γὰρ πρόσκειται αὐτῇ ἡ τοῦ ἀπογείου κίνησις.

This is table 33 Toomer.
I (to A.H. 740), II, III, IV, V, VI, VII, VIII, IX (0;1–0;30).
VIII in our notation:

$^{1}/_{2}$ 0;0,6,14^{0}
$^{1}/_{3}$ 0;0,4,9^{0}
$^{1}/_{5}$ 0;0,2,30^{0}
$^{1}/_{6}$ 0;0,2,5^{0}

Marginalium on f. 55

1. To I. Ἡ ἐποχὴ ἀπὸ Κριοῦ τῆς ὀγδόης σφαίρας.

Folios 56–58^{v}. Διὸς μήκους τε καὶ ἀνωμαλίας διόρθωσις.

This is table 41 Toomer without column 7.

Marginalium on f. 57

1. Ἡ διόρθωσις αὕτη ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κανόσιν.

Folios 59–59^{v}. Ἄρεος μέση κίνησις τοῦ μήκους ἄνευ τῆς κινήσεως τοῦ ἀπογείου.

This is table 35 Toomer.
I (to A.H. 840), II, III, IV, V, VI, VII, VIII, IX (0;1–0;30).
VIII in our notation:

$^{1}/_{2}$	$0;0,39,18^{0}$
$^{1}/_{3}$	$0;0,26,12^{0}$
$\langle{}^{1}/_{5}\rangle$	$0;0,15,43^{0}$
$\langle{}^{1}/_{6}\rangle$	$0;0,13,6^{0}$

Marginalium on f. 59

1. To I. Ἀπὸ τῆς ἀρχῆς τοῦ Κριοῦ τῆς η′ σφαίρας.

Folios 60–62^{v}. Μέσης κινήσεως Ἄρεος διόρθωσις.

This is table 42 Toomer without column 7.

Marginalium on f. 60

1. Ἡ διόρθωσις αὕτη τοῦ μὲν ἐπικύκλου ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κανόσιν, τοῦ δὲ ἐκκέντρου ἐλάσσων ἡ ἐνταῦθα μεγίστη τῆς ἐν τοῖς Προχείροις μεγίστης λεπτὸν πρῶτον ἕν.

Folios 63–63^{v}. Κίνησις Ἀφροδίτης ἀνωμαλίας.

This is table 35 Toomer.
I (to A.H. 840), II, III, V, VI, VII, VIII, IX (0;1–0;30).
VIII in our notation:

$^{1}/_{2}$	$0;0,46,14^{0}$
$^{1}/_{3}$	$0;0,30,40^{0}$
$\langle{}^{1}/_{5}\rangle$	$0;0,18,30^{0}$
$\langle{}^{1}/_{6}\rangle$	$0;0,15,20^{0}$

Marginalia on f. 63

1. To I. Ἡ ἐποχὴ αὕτη ἀπὸ τοῦ ἀπογείου τοῦ ἐπικύκλου ἐστίν.
2. To (IV). Μέση κίνησις τῆς Ἀφροδίτης οὐκ ἐκτέθειται ἐπειδὴ ἡ αὐτή ἐστι τῇ μέσῃ τοῦ Ἡλίου κινήσει· τὰ γὰρ κέντρα τῶν ἐπικύκλων Ἀφροδίτης καὶ Ἑρμοῦ τῷ κέντρῳ τοῦ Ἡλίου συμπορεύεται ἀεί.

Folios 64–66^{v}. Κινήσεως Ἀφροδίτης διόρθωσις τῆς ἀνωμαλίας.

This is table 43 Toomer without column 7.

Marginalium on f. 64

1. Ἡ ἐνταῦθα διόρθωσις τοῦ μὲν ἐπικύκλου ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κανόσιν, ἡ δὲ τοῦ ἐκκέντρου ἐλάσσων ἐστὶν ἡ ἐνταῦθα μεγίστη τῆς ἐν τοῖς Προχείροις μεγίστης μοῖραν α.

Folios 67–67^{v}. Μέση κίνησις τῆς τοῦ Ἑρμοῦ ἀνωμαλίας ἤτοι τοῦ ἐπικύκλου.

This is table 36 Toomer.
I (to A.H. 840), II, III, V, VI, VII, VIII, IX (0;1–0;30).
VIII in our notation:

$\langle 1/2 \rangle$	$0;3,53,0^{0}$
$1/3$	$0;2,38,20^{0}$
$1/5$	$0;1,33,12^{0}$
$1/6$	$0;1,17,0^{0}$

Marginalia on f. 67

1. To I. ⟨Ἐ⟩ποχὴ ⟨αὕ⟩τη ἐστὶν τοῦ ἀ⟨πο⟩γείου τοῦ ⟨ἐπι⟩κύ⟨κλ⟩ου.
2. To (IV). Μέση κίνησις τοῦ μήκους τοῦ Ἑρμοῦ οὐκ ἐκτέθειται ἐπειδὴ ἡ αὐτή ἐστι τῷ Ἡλίῳ.

Folios 68–70^{v}. Διόρθωσις ἀνωμαλίας Ἑρμοῦ.

This is table 44 Toomer without column 7.

Marginalium on f. 68

1. Ἡ διόρθωσις αὕτη ἴση ἐστὶ τῇ ἐν τοῖς Προχείροις κανόσιν.

Folios 71–73^{v}. Κανόνες στηριγμῶν τῶν πλανωμένων ἀστέρων.

This consists of the columns 7 of tables 40–44 Toomer.

Marginalium on f. 71

1. Οἱ στηριγμοὶ οὗτοι ἴσοι εἰσὶ τοῖς ἐν τοῖς Προχείροις κανόσιν.

Folios 74–76^{v}. Κανόνες διμερεῖς τῶν ἀριθμῶν τῆς κατὰ πλάτος παρόδου τῶν πλανήτων.

This is table 45 Toomer; for the tables of planetary latitude, see Toomer, 69–72.

Marginalium on f. 74

1. Οἱ κανόνες οὗτοι πολλῷ παραλλάττουσι τῶν Προχείρων, φασὶ δ'αὐτοὺς οὐκ ὀρθοὺς εἶναι.

Folios 77–78. Κανόνες τετραμερῶν ἀριθμῶν τοῦ πλάτους τῶν πλανήτων.

This is table 46 Toomer.

Folio 78^{v}. Κανόνες συνόδων Ἡλίου καὶ Σελήνης κατὰ τὴν μέσην κίνησιν ἐν ἔτεσιν Ἀράβων συνθέτοις ἐν τῷ μεσημβρινῷ τῆς Τολέτας.

This is table 52 Toomer for A.H. 691 (began 24 December 1291) to A.H. 1321; for the eclipse tables, see Toomer, 78–117.

Folio 78v. Κανόνες διαμέτρου Ἡλίου καὶ Σελήνης κατὰ μέσην κίνησιν ἐν ἔτεσιν Ἀράβων συνθέτοις ἐν τῷ μεσημβρινῷ τῆς Τολέτας.

This is table 53 Toomer for A.H. 751 (began 11 March 1350) to A.H. 1321.

Folio 79. Κανόνιον συνόδου καὶ διαμέτρου Ἡλίου καὶ Σελήνης ἐν ἔτεσιν Ἀράβων ἁπλοῖς ἐν τῷ μεσημβρινῷ τῆς Τολέτας.

This is table 54 Toomer.

Marginalium on f. 79

1. To the heading of column 4 (ἀναλογία ἀνωμαλίας Σελήνης [porcio Lune]). Γράφεται· μόρια ἡ ἀνωμαλία Σελήνης.

Folio 79v. Κανόνιον συνόδου καὶ διαμέτρου Ἡλίου καὶ Σελήνης ἐν μησὶν Ἀράβων.

This is table 55 Toomer; the months are not named, but are numbered 1 to 12. Heading of column 4: ἀναλογία Σελήνης. γράφεται καὶ μόρια Σελήνης.

Folio 79v. Κανόνιον προσνεύσεων ἀμφοτέρων τῶν ἐκλείψεων.

This is table 78 Toomer, with the erroneous repetition of 16 in the first column as in V.

Marginalia on f. 79v

1. To title. ⟨T⟩abula inflexionis ⟨.⟩ .... eclipsi.
2. To heading of column 1 (ἀριθμὸς σημείων διαμέτρου). Σημεῖόν ἐστι τὸ δωδέκατον τῆς διαμέτρου.
3. To heading of column 2 (ἀρχὴ ἐκλείψεως Ἡλίου καὶ τέλος ἀνακαθάρσεως). Inicium eclipsis Solis et finis eius ressessionis.
4. To heading of column 3 (ἀρχὴ ἐκλείψεως Σελήνης καὶ τέλος ἀνακαθάρσεως). ⟨I⟩nicium eclipsis Lune et finis eius ressessionis.

Folio 79v. Κανὼν ποσότητος σκοτισμοῦ ἀμφοτέρων τῶν ἐκλείψεων.

This is table 76 combined with variants of columns 1 and 3 of table 77 Toomer. The headings of this table are misleading:

columns 1 and 2: ποσότης ἐκλείψεως Σελήνης.

column 1: ἀριθμοὶ σημείων διαμέτρου.
column 2: ποσότης ἐπιφάνης ἐντισθείσης.

column 3: διόρθωσις τῆς διαφόρου κινήσεως ἐν μιᾷ ὥρᾳ. σημεῖα πρὸς Ἥλιον.

columns 4 and 5 (columns 1 and 3 of table 77 Toomer):

ἀπόστασις μεταξὺ Ἡλίου καὶ Σελήνης.

column 4		column 5	
ἀριθμοί	δεύτερα	ἀριθμοί	δεύτερα
α	ō	ō	λ
α	ō	α	ι
β	α	β	η
		γ	ι
γ	β	δ	κ
		ς	λ
δ	γ	η	με
		ϑ	ō
ε	δ	ι	ι
		ια	κ
ς	ε	ιβ	κ
		ιβ	ō
ζ	ς	ō	ō

Folio 80. Κανὼν διαφόρου κινήσεως Ἡλίου καὶ Σελήνης ἐν μιᾷ ὥρᾳ διορθωμένη ἤτοι ἀκριβής.

This is table 56 Toomer.

Folio 80. Κανὼν μορίων[a] Σελήνης διορθώσεως.

This is table 79 Toomer.

Marginalia on f. 80

1. To title. Tabula porcionis vel ecacionis.
2. To heading of column 2 (μόρια ἀποστάσεων). ἐν τῷ Ἰταλικῷ γράφεται πορσίονε⟨ς⟩ porcion⟨es⟩.
3. To heading of column 4 (κύκλος ἔκκεντρος). sirculus egressus.

a. MS wrote ἀναναλογίας, crossed it out, and wrote μορίων above.

Folio 80v. Κανόνες διαφορᾶς ἐποχῆς Σελήνης πρὸς τὸ πλάτος τῆς Τολέτας, ὅ ἐστι μοιρῶν λϑ λεπτῶν νδ· ὥραι αὐτοῦ ιδ λεπτὰ κζ.

This is table 63 Toomer.

Marginalia on f. 80v

1. Οἱ κανόνες οὗτοι τῆς παραλλάξεως οὐ συμφωνοῦσι τοῖς Προχείροις διὰ τὸ ἐπὶ ἀνομοίου πλάτους τῶν κλιμάτων ἐκτίθεσθαι ἐνταῦθα κἀκεῖ.
2. Το ἀναποδισμός in the middle of Cancer. ressessio. οὕτω τὰ ἑξῆς πάντα.

Folio 81. Κανόνες διαφορᾶς ἐποχῆς ἐν τῷ τετάρτῳ κλίματι, οὗ πλάτος μοῖραι λς λεπτὰ κδ· ὥραι αὐτοῦ ιδ λεπτὰ κζ.

This is table 66 Toomer.

Folio 81v. Κανόνες διαφορᾶς ἐποχῆς ἐν πέμπτῳ κλίματι, οὗ πλάτος μοῖραι μα λεπτὰ μδ· ὥραι αὐτοῦ ιε λεπτὰ ϑ.

This is table 67 Toomer.

Folio 81v. Ὑποποδισμοὶ τῶν πλανήτων τὰ ἄνω (written below the table).

This is table 51 Toomer, but the numbers are wrongly interpreted as integers rather than as integers plus fractions; there are many errors of reading as well. I reproduce the table therefore.

ὀνόματα πλανήτων	μεγίστη ἀπόστασις	ἡμέραι	μέση ἀπόστασις	ἡμέραι	ἐλαχίστη ἀπόστασις	ἡμέραι
Κρόνος	α,ζυι	ρμζ μζ	ζ,ακη	ρλη	ψιη	ρλς
Ζεύς	ζ,δϡιδ	ρκγ	ϑ,ασις	ρκα	ϑ,ευμ	ριη
Ἄρης	ιϑ,ετλβ	π	ις,αωμδ	ογ	ιβ,ασιδ	ξδ λ
Ἀφροδίτη	ιϑ,βφκς	μγ	ιε,αψλδ	μα μ	α,δψλη	λ μ
Ἑρμῆς	ζ,ευκβ	κα	ιβ,αψι	κβ λ	ιβ,ασι	ξς μη

Folio 81v. No title.

This is table 77 Toomer.

Folio 81v. Κανὼν κινήσεων πλανήτων ἐν ἡμέρᾳ μιᾷ (written below the preceding table).

This is a table of the mean daily motions of the anomalies of the planets, expressed in seconds (except of Venus).

Saturn	3428 = 0;57,8⁰
Jupiter	3249 = 0;54,9⁰
Mars	1662 = 0;27,42⁰
Venus	37 = 0;37⁰
Mercury	11184 = 3;6,24⁰

Folio 82. Κανόνες ἐκλείψεως Ἡλίου ἐν τῇ μεγίστῃ ἀποστάσει ἤτοι τῷ ἀπογείῳ τοῦ ἐπικύκλου.

Κανόνες ἐκλείψεως Ἡλίου ἐν τῇ ἐλαχίστῃ ἀποστάσει.

This is table 59 Toomer.

Marginalium on f. 82

1. Τῆς Σελήνης ἐν συνόδῳ καὶ διαμέτρῳ σὺν τῷ ἑαυτῆς ἀπογείῳ εὑρισκομένης ἀδύνατον νοεῖν τὴν ἐνταῦϑα μεγίστην καὶ ἐλαχίστην ἀπό⟨στασιν⟩, τὸ ἀπόγειον καὶ περίγειον τοῦ ἐκκέντρου, ἀλλὰ τοῦ ἐπικύκλου.

Folio 82v. Κανὼν ἐκλείψεως Ἡλίου ἐν μεγίστῃ ἀποστάσει.
Κανὼν ἐκλείψεως Ἡλίου ἐν ἐλαχίστῃ ἀποστάσει.
Κανὼν ἐκλείψεως Ἡλίου ἐν μεγίστῃ ἀποστάσει.
Τοῦ αὐτοῦ ἐν ἐλαχίστῃ ἀποστάσει.

This is table 58 Toomer.

Marginalium on f. 82v

1. To heading of column 1 of the first table (μόρια πλάτους). γράφεται πορσίονις παρ' Ἰταλοῖς.

Folio 83. Κανόνες ἀναλογίας.

This is table 80 Toomer.

Folio 83v. Κανόνες ἐκλείψεως Σελήνης ἐν μεγίστῃ ἀποστάσει.
Κανόνες ἐκλείψεως Σελήνης ἐν ἐλαχίστῃ ἀποστάσει.

This is table 61 Toomer.

Marginalia on f. 83v

1. To heading of column 1 of first table (ἀπόστασις Σελήνης ἀπὸ τοῦ συνδέσμου). longitudo Lune a nodo.
2. To heading of column 5 of first table (μονῆς). mora.

Folios 84–84v. Κανὼν ἐκλείψεων Σελήνης ἐν μεγίστῳ ἀποστήματι (i).
Κανὼν ἐκλείψεων Σελήνης ἐν ἐλαχίστῃ ἀποστάσει (iii and i mixed).
Κανὼν ἐκλείψεως Σελήνης ἐν μεγίστῳ ἀποστήματι (ii).
Κανὼν ἐκλείψεως Σελήνης ἐν ἐλαχίστῳ ἀποστήματι (iv).
Κανὼν ἐκλείψεως Σελήνης ἐν ἐλαχίστῳ ἀποστήματι (iii).

This is table 60 Toomer.

Marginalia on f. 84

1. To heading of column 4 in second table (μέσον μονῆς). dimidium more.
2. To heading of column 2 in fourth table (σημεῖα ἐκλείψεως). σημαίνει τοὺς δακτύλους, φασίν, ἤτοι τὸ ιβ' τῆς διαμέτρου.

Folio 84v. Διάστασις κατὰ μῆκος καὶ πλάτος ἀστέρων πρὸς τὸν ἰσημερινόν.

This is table 82 Toomer; for the star-catalogue, see Toomer, 123–33. The Byzantine catalogue belongs to Toomer's first type, with 40 stars. Only some of the Greek star-names are given in section 1 (stars 1–14) with some of the Latin originals in the margin; in sections 2 (stars 15–28) and 3 (stars 29–40) no star-names are given save for those in the marginalium. I number the stars according to Toomer's list.

(margin)	ὀνόματα ἀστέρων ἀπλανῶν	μῆκος	πλάτος
1.	καρδία Ταύρου	Ταυ κς μζ	ε ι νο.
2.	πόδες Ὠρίωνος	ζ	λα ν νο.
3. alaich		Διδ ϑ ζ	κβ ν βο.
4. humerus Orinis		Διδ ις ζ	ιζ ō νο.
5. alahabor	καρδία Λέοντος	Καρ α μζ	λϑ ι νο.
6. algomeissa	οὐρὰ Λέοντος	Καρ ιγ ιζ	ις ι νο.
7.	καρδία Λέοντος	Λέ ις λζ	ō ι βο.
8.	οὐρὰ Λέοντος	Παρ η λζ	ια ν βο.
9. alramoth id est lanseator		Ζυγ κα ζ	κα λ βο.
10. alatsel inermis		Ζυγ ι μζ	β ō νο.
11. vultur cadens		Αἰγ α κζ	ξβ ō βο.
12. vultur volans		Αἰγ ιζ ō	κϑ ι βο.
13.	ἄκανθος νοτίου ἰχθύος	Ὑδρ κα ζ	κγ ō νο.
14.	κεφαλὴ γυναικός	Κρι α λζ	κς ō βο.

15.	Ταυ	ιγ	μζ	κγ	ō	βο.	28.	Ἰχϑ	ις	ιζ	λα	ō	βο.
16.	Διδ	δ	κζ	ιζ	ν	νο.	29.	Παρ.	κη	κζ	ιϑ	μ	νο.
17.	Διδ	ις	λζ	κ	ō	βο.	30.	Κρι	ιη	ō	κς	κ	βο.
18.	Καρ.	ζ	κζ	ϑ	μ	βο.	31.	Κρι	κα	μζ	η	κ	βο.
19.	Καρ.	ϑ	μζ	ς	ιε	βο.	32.	Ταυ	α	β	κη	ō	βο.
20.	Λέ.	ις	ιζ	η	ν	βο.	33.	Διδ	ϑ	μζ	η	ō	βο.
21.	Λέ	ιδ	ζ	κ	ν	νο.	34.	Διδ	κη	μζ	ι	ν	νο.
22.	Σκο	β	ζ	ō	μ	βο.	35.	Το	η	λζ	λς	ō	βο.
23.	Σκο	ς	ιζ	η	λ	βο.	36.	Ὑδρ.	ιϑ	κϑ	κβ	ν	βο.
24.	Το	κς	μϑ	γ	ō	νο.	37.	Ἰχϑ	κϑ	μζ	κ	κ	νο.
25.	Αἰγ.	α	ζ	ιη	ō	νο.	38.	Το	ια	λζ	ιγ	ζ	νο.
26.	Αἰγ.	α	νβ	κγ	ō	νο.	39.	Το	κς	κη	β	ν	βο.
27.	Ὑδρ	κγ	ιζ	ξ	ō	βο.	40.	Το	κε	νη	ō	κβ	νο.

Marginalium on f. 84v

1. Ἀστέρες τῆς β′ σελίδος ιδ οὗτοι· cap algol humerus sinistrum Orion.

This Greek version was used by P. Kunitzsch in his edition of Typ XII (*Typen von Sternverzeichnissen in astronomischen Handschriften des zehnten bis vierzehnten Jahrhunderts* [Wiesbaden, 1966], 73–82).

Folio 85. Κανὼν διαστάσεων χωρῶν κατὰ μῆκος ἀπὸ δυσμῶν, κατὰ πλάτος δὲ ἀπὸ τοῦ ὕψους τοῦ βορείου πόλου.

This is table 83 Toomer; for this geographical list, see Toomer, 134–39. The Byzantine translator gives the names of the localities in Latin script, the coordinates in Greek numerals. I give also the numbers of Toomer's edition of V in parentheses; the Byzantine list is more complete. There are four double-columns, separated by horizontal lines.

ὀνόματα χωρῶν	μῆκος	πλάτος
(1) Tageta	ς λ	λε ιε
(2) Cepta	η ō	λε κ
(3) Cordunba	ϑ κ	λζ λ
(4) Rodage (?)	ια ō	μ ō
(5) Sigilmessaha	ιε ō	κβ ō

ὀνόματα χωρῶν	μῆκος		πλάτος	
(6) Ganah	ιε	λε	ι	με
(7) Siege dou roy de Frans	κγ	με	με	ν
(8) Insula Tule	ι	ō	νη	ι
(9) Cartage	κζ	ō	λζ	ō
(10) Tunis	κϑ	ō	λη	ō
(11) Emeria	η	ō	μα	νε
(12) Balgohs	ρη	λε	λη	μ
(13) Albeith	ρλ	ō	λη	ō
(14) Sivita regis Acin	ροζ	ō	ιη	λ
(15) Aracah	ογ	λς	λς	ō
(16) Melcah	ξζ	ō	κα	ō
(17) Gedda	ξς	λ	κ	ιε
(18) Almedina	ξε	κ	κε	ō
(19) Alglas	ξγ	ν	κδ	ō
(20) Yspanem	οε	ō	λδ	λ
(23) Choarisimi	ϙα	ν	μβ	ι
(24) Chebil	ρ	ō	κη	ō
(25) Albazra	οδ	ō	λα	ō
(26) Hamem	πδ	λ	ιϑ	με
(27) Adramant	οα	ō	ιβ	λ
(28) Sahana	ξγ	λ	ιδ	λ
(29) Armenia	οζ	ō	μα	ō
(30) Bucarre	ρζ	κ	λς	ν
(31) Cenedin	ρκε	ō	γ	ō
(32) Almedia id est Africa	λβ	ō	λς	ō
(33) Cirenem	λα	ō	λε	λ
(34) Insula Sadenia	λα	ō	λη	ō
(35) Roma	λε	κε	μα	ν
(36) Cabis	λς	ō	λβ	ō
(37) Insula Merzola	λζ	ō	λζ	ō
(38) Insula Sicilie	λς	ō	λϑ	ō
(39) Malta	λη	ō	λς	ō
(40) Trabus Arabum	μ	ō	λγ	ō
(41) Barca	μζ	γ	λα	ō
(42) Alexandria	να	κ	λα	ō
(43) Dimiat	νδ	ō	λα	ō
(44) Tenis	νδ	μ	λα	ō
(45) Eraclia	νγ	κε	μς	με
(46) Sivitas Anuba	νγ	ō	ιδ	λ
(47) Bagdad	ο	ō	λγ	κε
(48) Egipte	νε	ō	λ	ō
(49) Aluz Melsara	νς	λ	κη	κ
(50) Assuen	νς	ō	κβ	λ

ὀνόματα χωρῶν	μῆκος		πλάτος	
(51) Alcarme	νε	μ	λα	λ
(52) Ascalen id est Ascalon	νε	μ	λβ	ō
(53) Araula	νς	ō	λβ	ιε
(54) Ierusalem	νς	ō	λβ	ō
(56) Alconsantina	μϑ	ō	με	ō
(57) Panormi			λη	ις
(58) Damasco	ξ	ō	κζ	ō
(59) Trabuliz Casso	ξ	λε	λδ	ō
(60) Amogil	ξϑ		λε	λ
(61) Melfie			μα	κδ
(62) Alsufa	ξϑ	λ	λα	ν
Cremona	λα	ō	με	ō
(21) Alre	πς	ō	λζ	λ
(55) Saur	νζ	ō	λγ	ō
(22) Fragana	πς	ō	λς	ō
Almana	ιζ	ō	λς	ν
Valensia	λ	κ	λϑ	λς
Scidilira	κε	λε	λζ	λ
Marochus	κα	ō	λα	ō
Insula †mstae?	ρος	λ	ε	με
Musac	ρξη	με	δ	με
Mincta	ροζ	ō	ιη	λ
Rata	ογ	ō	λς	λς
Carsen	ϙ	ō	λ	ō
Adesso	με	ō	ις	ō
Mansora	ϙγ	ō	κβ	ō
Albuth	νγ	ō	ιδ	λ
Toletu	κζ	με	λϑ	λδ
Bertagriam	κε	κγ	λϑ	λ
Serragosa	κϑ	νε		

Folios 85v–87. Κανὼν τῶν φάσεων τῶν ζῳδίων.

This is table 85 Toomer; for the astrological tables, see Toomer, 140–51.

Marginalium on f. 85v

1. To title. Φάσεις τοὺς δεκανούς φησιν. That is, φάσις is a transliteration of the Latin facies.

Marginalium on ff. 85v–86

1. *Si vis scire aspectum cuiusvis planete, aspice primo gradu ascendentis cuius facies signi sit. Cum eadem facie signi intra tabulam facierum secundum circulum tabularum, et gradum et minutum quod inveneris scribe ad partem. Deinde cum gradu signi ubi est planeta intra tabulam circuli obliqui secundum clima tuum, et scribe gradi et minute seorsum. Deinde cum ultimo gradu signi ilius planete intra iterum predicti circuli obliqui, et gradi et minuta quam inveneris scribe super alios gradus. Et subtrae maiorem a minory, et diferencia subtrae a gradibus et minutis faciey signi; et ilud quod remanserit serva. Deinde intra tabulum* [f. 86] *circuli obliqui, et accipe*

gradu et minuta ꝑocrva? loci gradi signi ubi est planeta. Deinde differenciam quam servasty subtrahe a gradu et minuto locy planete a tabula circuli obliqui, et cum ilis quod remanserit intra tabulam circuli obliqui. Et ile erit gradus aspectus. Et isto modo operaberis in quodlibet aspectum.

Folio 87v. Κανὼν τῶν φάσεων καὶ τῶν κρύψεων τῶν πλανήτων.

This is table 49 Toomer.

Marginalium on f. 87v

1. To title. *Tabula de visione et ocultacione illorum.*

Folio 88. No title.

This is an arrangement of Table 81 (ii and iii) Toomer; on the trepidation theory, see Toomer, 118–22. The 90° of argument are distributed among the four groups of three signs in the first four columns (0, 1, 2; 5, 4, 3; 6, 7, 8; and 11, 10, 9); the intervals are 5°. Column 5 is column 2 of table 81 (ii), entitled: *distancia capitis Arietis ab equatore.* And column 6 is column 2 of table 81 (iii), and bears the same title. This is followed by two versions of table 81 (iii), one with increasing values, the other with decreasing; the double argument in each is for 5° to 90° and 355° to 270°.

Marginalium on f. 88.

1. To title. *Ista tabula motus spere dicitur, quod non sit de hoc libro; Hali est sicut.*

Folio 88. Κανόνιον μέσης κίνησις ἐπιδρομῆς καὶ ἀναποδισμοῦ.

This is table 81 Toomer. The collected years in table 81 (i) extend to A.H. 840.

Marginalia on f. 88

1. To title. *Tabula motus medii accessionis et recessionis.*
2. *Anni solares in Canone motus* 365;15,23.
3. *Que augetur secundum asensiones; ac conducis ad revolusiones sequentis anni* 92 *gradus* 15 *minuta* 30.
4. Εἰ ἔχεις τὸν ὡροσκόπον τοῦ παρελθόντος ἐνιαυτοῦ, πρόσθες μοίρας ϛβ λεπτὰ ιε δεύτερα λ, καὶ εὑρήσεις τὸν ὡροσκόπον τοῦ ἐπιόντος ἐνιαυτοῦ.

An excess of revolution of 92;15,30° corresponds to a year-length of 365;15,22,35 days; a year-length of 365;15,23 days would correspond to an excess of revolution of 92;18°. Therefore, the parameter in marginalium 2 is a rounding off of that in 3 and 4.

Folios 88v–89. No title.

This is table 13 Toomer; for the tables relating to trigonometry and spherical astronomy, see Toomer, 27–43.

Marginalia on f. 88v.

1. To title. *Tabula sinus.*
2. To heading of column 1a (περιφερείας μόρια). *Arcus minor et porcio circuli.*
3. To heading of column 1b (περιφερείας ἀνωμαλίας). *Arcus argumentati.*
4. To heading of column 2 (τὸ ἥμισυ τῆς εὐθείας τῆς ὑποτεινούσης τὴν περιφέρειαν). *Corde mediate sive sinus.*

Folio 89. Κανὼν ἐγκλίσεως ἀληθεύων ἐν ἐγκλίσει ἀπὸ τοῦ ἰσημερινοῦ μοίρας κγ λεπτὰ λ δεύτερα λ.

This is table 14 Toomer, with the expected obliquity of 23;33,30⁰ rather than the variant in the title.

Folios 89ᵛ–90. No title.

This is table 12 Toomer.

Marginalia on f. 89ᵛ

1. To heading of column 1b (περιφέρεια). *Porcio circuli.*
2. To heading of column 2 (τὸ ς τῆς ὑποτεινούσης). *Sinus sive corda.*

Marginalium on f. 90

1. To title. *Sinus vel arcus et declinacionis tabula.*

Folio 90ᵛ. Κανὼν διαφορᾶς τῶν ἀναφορῶν ἐν πάσῃ τῇ γῇ·

This is table 16 Toomer.

Folio 90ᵛ. Κανὼν σκιᾶς τῆς γῆς.

This is table 15 Toomer.

Folio 90ᵛ. No title.

This is table 38 Toomer.

Folios 91–91ᵛ. Κανὼν ἀναφορᾶς τῶν ζῳδίων ἐν σφαίρᾳ ὀρθῇ.

This is table 17 Toomer.

Folios 92–92ᵛ. Ἀναφοραὶ ζῳδίων κατὰ τὴν πόλιν Τολέτας, ἧς πλάτος μοῖραι λθ λεπτὰ νδ· ὧραι αὐτῆς ἰσημεριναὶ ιδ λεπτὰ να.

This is table 18 Toomer.

Folios 93–93ᵛ. Ἀναφοραὶ ζῳδίων ἐν τῇ Κρεμώνῃ πόλει, ἧς πλάτος μοῖραι με.

This is table 19 Toomer.

Folios 94–96ᵛ. Διόρθωσις τῶν οἴκων ἐπὶ τῆς Τολέτας.

This is table 84 Toomer.

Folio 97. Κανὼν ἐν ἔτεσιν τοῦ κυρίου ἡμῶν Ἰησοῦ Χριστοῦ.

This is table 1 Toomer; for the chronological tables, see Toomer, 14–26. The collected years in column 1 extend to 504 and then from 1120 to 1372.

Folio 97. Κανὼν ἐν ἔτεσι Γεσδαγὲτ βασιλέως Περσῶν.

This is table 3 Toomer. The collected years extend to AY 900 (which began 4 November 1530). The Persian months are numbered, but not named.

Marginalium on f. 97

1. Μεταξὺ Ἀλεξάνδρου καὶ Γεσδαγὲτ βασιλέως Περσῶν εἰσιν ἡμέραι τετάρτη μία τρίται κδ δεύτεραι λη καὶ πρῶται κ.

The number is 1,24,38,20; in fact, there are 1,34,38,20 days between the Seleucid era ("Alexander") and the Hijra ("the Arabs"). See Toomer, 18.

Folio 97. Κανὼν ἐν ἔτεσιν Ἀλεξάνδρου βασιλέως.

This is table 4 Toomer. The collected years extend to SE 1600 (which began 1 October 1289). The Syrian months are numbered, but not named.

Folio 97v. No title.

This is table 5 Toomer. The collected years extend to A.H. 600 (which began 10 November 1203). The Greek transliterations of the Latin transliterations of the Arabic month names are:

Arabic	Latin (Toomer, 15.)	Greek
Muḥarram	*Almuharam*	Ἀμνιαχάρα
Ṣafar	*Saphar*	Σεφάτ
Rabīʿ al-awwal	*Rabe primus*	Ῥάμπε πρῶτος
Rabīʿ al-thānī	*Rabe ultimus*	Ῥάμπε νόβις
Jumādā al-ūlā	*Jumedi primus*	Τζιμεδι πρῶτος
Jumādā al-ākhira	*Jumedi ultimus*	Τζιμεδι νόβις
Rajab	*Rageb*	Ῥατζεπ
Shaʿbān	*Sahaban*	Σαβάν
Ramaḍān	*Ramadan*	Ῥαμαδάν
Shawwāl	*Sahuel*	Σανέτ
Dhū al-qaʿda	*Dulcheda*	Δουλστζέδα
Dhū al-ḥijja	*Dulchera*	Δουλστζές

Instead of *Rabe ultimus* and *Jumedi ultimus* the exemplar used by the Greek translator must have had *Rabe novus* and *Jumedi novus*.

Marginalia on f. 97v

1. Ἡ ἡμέρα ἡ πρώτη ἐστὶν ἡμέρα μία, ἡ δευτέρα εἰσὶν ἡμέραι ξ, ἡ τρίτη εἰσὶν ἡμέραι ,ΥΧ, ἡ δὲ τετάρτη ἡμέρα εἰσὶν ἡμέραι[a] χιλιάδες διακόσιαι δέκα ἓξ.

a After ἡμέραι MS adds, but crosses out, βας.

1 = 1
1,0 = 60
1,0,0 = 3,600
1,0,0,0 = 216,000

2. Ἡ τρίτη ἡμέρα ἔτη Αἰγύπτια Θ ἡμέραι τιε.

3,600 days = 9 Egyptian years and 315 days.

3. Ἡ τετάρτη ἡμέρα ἔτη φϙα ἡμέραι ρπε.

216,000 days = 591 Egyptian years and 285 days.

Folio 98. No title.

This is columns 1 to 5 of table 6 Toomer. The collected Arabic years extend to A.H. 660.

Marginalium on f. 98

1. To title. *Anni here pro radice Persici hii sunt qui ante duos Arabum conversi erunt.*

Folio 98. No title.

This is table 9 Toomer. The collected years extend to A.H. 900. The Arabic months are numbered, but not named.

Marginalium on f. 98

1. To title. *Tabula ad inveniendum principium cuiuslibet, id est mensis lunaris.*

Folio 98. No title.

This is a table of the weekday with which each mean synodic month from 1 to 37 begins; the mean synodic month is taken to comprise 29 days and 12 793/1080 hours or 29;31,50,8,20 days. This is a Babylonian parameter for the synodic month in System B; see O. Neugebauer, *Astronomical Cuneiform Texts*, 3 vols. (London, 1955), I, 70. It is also used in medieval Hebrew astronomy; see, e.g., O. Neugebauer, in S. Gandz, J. Obermann, and O. Neugebauer, *The Code of Maimonides: Book Three, Treatise Eight. Sanctification of the New Moon* (New Haven, 1956), 114. The fraction of an hour 793/1080 appears already in the *Talmud*; see S. Gandz, "Complementary Fractions in Bible and Talmud," *Louis Ginzberg Jubilee Volume* (New York, 1945), 143–57, esp. 148. It must be from some Jewish source that the table entered the version of the *Toledan Tables* translated into Greek. The še (Babylonian) or ḥeleḳ (Hebrew) is called here σημεῖον. It appears also under the name ποῦντος in a fifteenth-century Byzantine mathematical manuscript (H. Hunger and K. Vogel, *Ein byzantinisches Rechenbuch des 15. Jahrhunderts* [Vienna, 1963], 64, 66, 76, and 112, as was recognized by Toomer (*Scripta Mathematica*, 28 [1967], 76).

Folio 98v. No title.

This table is composed of elements of tables 6 and 9 Toomer.
There are 5 sections:

I. Column 4 (*ferie*) of table 9 Toomer.

II. Column 3 (1 to 30 years) of table 9 Toomer.

III. Columns 19–22 (*anni Christi expansi, menses, dies*, and *quarte*) of table 6 Toomer.

IV and V. Columns 26–29 (*tabula ad omnes menses lunares*) of table 6 Toomer. The column corresponding to column 27 (μῆνες Ἀράβων) is left blank. The heading of III is: *Anni here sive solares.*

Folio 98v. No title.

This is table 11 Toomer without the Syrian names of the months.

Folio 99. Κανὼν δεικνὺς τὰς σεληνιακὰς ἡμέρας διὰ μοναδικοῦ τῶν ιβ μηνῶν ἡλιακῶν ἐν ιϑ ἔτεσιν ἀνακύκλου τῆς Σελήνης.

This is a table of the month and day on which each synodic month in a 19-year cycle begins; the first begins on 9 January of year 1, the last on 7 December of year 19.

Folio 99. No title.

This is a 19-year Easter-cycle beginning, as does the Alexandrian cycle, on 5 April; see V. Grumel, *La chronologie* (Paris, 1958), 54–55. Column 1 lists the ἔτη Σελήνης from 1 to 19. Column 2, which is headed *pascales cursus*, gives the number of the day of the month (which is not named) on which Easter falls; these numbers agree with those of the Alexandrian cycle. Column 3, which is headed ... *pascales*, gives a week-day number. This increases by 3 in normal years, by 5 in years to which an intercalary month has been added (years 3,6,8,11,14,17, and 19). This indicates that a normal year contains twelve 30-day months or 360 days = 7·51 + 3 days, an intercalary year thirteen 30-day months or 390 days = 7·55 + 5 days. These "days," then, are tithis, and it is absurd to treat them as civil days. The column begins with 5.

Folio 99. Σχηματισμοὶ πρὸς τὴν Σελήνην τῶν λοιπῶν πλανήτων.

This table is set up to show sextile, trine, quartile, opposition, and conjunction of Saturn, Jupiter, Mars, the Sun, Mercury, and the head or tail (ascending or descending node) with the Moon; nothing is filled in.

Folio 99. Μέση κίνησις Κρόνου ἐν λεπτοῖς ὡρῶν.

This is column 6 of table 32 Toomer, but for 31 to 60 minutes.

Folio 99. Ἀνωμαλίας Ἑρμοῦ ἐν λεπτοῖς ὡρῶν.

This is column 6 of table 36 Toomer, but for 31 to 60 minutes.

Folio 99v. Κανὼν ἐν μησὶ καὶ ἡμέραις Ἀράβων.

This is table 1 Toomer. The collected years are for 588 to 1456.

Folio 99v. No title.

This is table 2 Toomer. The collected years are for 1 to 871; the Arabic months are numbered, but are not named.

Folio 99v. No title.

This is table 10 Toomer. The Arabic months are numbered, but are not named.

Folio 100. Κανὼν τῶν φάσεων τῶν πλανήτων.

This is a table of the lords of the decans (*facies* in Latin).

Folio 100. Ὅρια τῶν ε πλανωμένων ἐν ἑκάστῳ ζῳδίῳ κατὰ Πτολεμαῖον.

This is a table of the lords of the terms.

Folio 100. Ὑψώματα πλανήτων.

This is a table of the exaltations of the Sun, the Moon, Saturn, Jupiter, Mars, Venus, Mercury, and the head and the tail (the ascending and descending nodes).

Folio 100. No title.

This is a table of the *gradus putei*. Below it is written: τὸ ἄνω κανόνιον Ἰταλικὸς οὕτω· tabula puthei planetarum.

Folio 100. Κανὼν Ἡλίου.

This is a table of the mean longitudes of the Sun when it enters each sign of the zodiac. I add the equations.

Aries	$11^s\ 28;3,31^0$	$+\ 1;56,29^0$
Taurus	$0^s\ 28;31,40^0$	$+\ 1;28,20^0$
Gemini	$1^s\ 29;23,32^0$	$+\ 0;36,28^0$
Cancer	$3^s\ 0;29,7^0$	$-\ 0;29,7^0$
Leo	$4^s\ 1;19,58^0$	$-\ 1;19,58^0$
Virgo	$5^s\ 1;53,26^0$	$-\ 1;53,26^0$
Libra	$6^s\ 1;56,34^0$	$-\ 1;56,34^0$
Scorpio	$7^s\ 1;28,13^0$	$-\ 1;28,13^0$
Sagittarius	$8^s\ 0;36,21^0$	$-\ 0;36,21^0$
Capricorn	$8^s\ 29;34,55^0$	$+\ 0;25,5^0$
Aquarius	$9^s\ 28;40,8^0$	$+\ 1;19,52^0$
Pisces	$10^s\ 28;6,41^0$	$+\ 1;53,19^0$

The apogee is at about Gemini 18^0, and the equations seem to be those of the *Toledan Tables* save that that for Cancer should be $-\ 0;25,7^0$ instead of $-\ 0;29,7^0$.

Marginalium on f. 100

1. To title. *Tabula ad ingressum Solis et primum secundum cuiuslibet signi inveniendum.*

Folio 100v. *Tabula de firdaruo planetarum.*

This is a table of the lords of the fardāriyas and their participants; see D. Pingree, *The Thousands of Abū Ma'shar* (London, 1968), 62–63.

Folio 100v. Κανὼν ὑποποδισμοῦ καὶ προποδισμοῦ τῶν πλανωμένων.

This is a table of the smallest entries (στηριγμὸς πρῶτος) and the largest entries (ὑποποδισμός) in column 7 of tables 40–44 Toomer, and of 360^0 diminished by each.

Folio 100v. No title.

This is a table of the same numbers expressed in degrees and minutes rather than in signs, degrees, and minutes, and arranged with the planets' names at the side rather than at the top.

Folio 101. Κανὼν τοῦ ὕψους τοῦ Ἡλίου ἐν τῷ μεσημβρινῷ ἐν κλίματι ἔχοντι μοίρας με.

This is a table of the noon altitude of the Sun for each degree of solar longitude at a terrestrial latitude of 45^0. The maximum altitude is 68;33,30^0 when the Sun is at Cancer 0^0, the minimum 21;26,30^0 when the Sun is at Capricorn 0^0. The obliquity of the ecliptic, therefore, is taken to be 23;33,30^0 as in table 14 Toomer.

Folio 101v. Diagram of the eccentric solar model.

Folio 102. Diagram of the lunar model with eccentric and epicycle.

Folio 102v. Diagram of the lunar orbit and the ecliptic intersecting at the lunar nodes.

Folio 103. Diagram of the relative positions of the Sun and the Moon at eclipses.

Folio 103v. Diagram of the motion of the equinoxes in trepidation.

Folio 104. Μέση κίνησις Ἡλίου ἐν ὥραις ἰσημεριναῖς.

This is column 5 of table 28 Toomer.

Folio 104. Μέση κίνησις Σελήνης ἐν ὥραις.

This is column 5 of table 29 Toomer.

Folio 104. Μέση κίνησις Ἡλίου ἐν λεπτοῖς ὡρῶν.

This is column 6 of table 28 Toomer.

Folio 104. Μέση κίνησις Σελήνης ἐν λεπτοῖς ὡρῶν.

This is column 6 of table 29 Toomer.

Folio 104v. Ἀνωμαλία Σελήνης ἐν ὥραις.

This is column 5 of table 30 Toomer.

Folio 104v. Ἀνωμαλία Σελήνης ἐν λεπτοῖς ὡρῶν.

This is column 6 of table 30 Toomer.